Final

Interim Record of Decision

Interim Remedial Action for Installation-Wide Groundwater

Redstone Arsenal
Madison County, Alabama
U.S. EPA ID No. AL7 210 020 742

Prepared for:

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Table of Contents

Page No.

Table of Contents (Continued)

Page No.

List of Tables

List of Figures

List of Acronyms

ADEM	Alabama Department of Environmental Management
ARAR	applicable or relevant and appropriate requirement
Army	U.S. Army Garrison – Redstone
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	chemical(s) of potential concern
DDT	dichlorodiphenyltrichloroethane
DWEL	drinking water equivalency level
EPA	U.S. Environmental Protection Agency
FS	feasibility study
IRA	Interim Remedial Action
IRAO	interim remedial action objective
IROD	Interim Record of Decision
IRP	Installation Restoration Program
IWGW	Installation-Wide Groundwater
LUC	Land-Use Control
MCL	maximum contaminant level
µg/L	micrograms per liter
MSFC	George C. Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	operation and maintenance
OU	operable unit
PCB	polychlorinated biphenyl
PP	Proposed Plan
PRG	preliminary remediation goal
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	remedial investigation
ROD	Record of Decision
RSA-057	Inactive Arsenic Waste Lagoons - East
RSA-099	Abandoned Plating Shop Tanks and Sump, Building 7614
SAC	site access control
Shaw	Shaw Environmental, Inc.

List of Acronyms *(continued)*

SVOC	semivolatile organic compound
SWMU	solid waste management unit
TCE	trichloroethene
VOC	volatile organic compound

1.0 The Declaration

1.1 Site Name and Location

Installation-Wide Groundwater
Redstone Arsenal
Madison County, Alabama

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Identification Number: AL7 210 020 742

U.S. Army Garrison - Redstone

1.2 Statement of Basis and Purpose

This Interim Record of Decision (IROD) presents the Selected Remedy, Land-Use Controls (LUC), as an Interim Remedial Action (IRA) for Installation-Wide Groundwater (IWGW) at the U.S. Army Redstone – Garrison (hereinafter referred to as the Army or Arsenal). Redstone Arsenal is located in Madison County, Alabama (Figure 1). The IRA was chosen in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The remedy selection was based on information available in the Administrative Record file for groundwater under the Arsenal, including the Proposed Plan (PP) for IWGW (Shaw Environmental, Inc. [Shaw], 2007). This IROD has been prepared in accordance with U.S. Environmental Protection Agency (EPA) guidance (EPA, 1999). By implementing the LUCs in this IROD, the Army plans to protect Arsenal workers and on-post residents from consumption of the Arsenal groundwater until final actions are selected in the final Records of Decision (ROD) for the groundwater sites.

This document is issued by the Army, who is the lead agency for site activities under CERCLA at Redstone Arsenal. The EPA Region 4 and the Alabama Department of Environmental Management (ADEM) are the regulatory agencies providing oversight of the Army's cleanup program at Redstone Arsenal. The Army and EPA Region 4 have selected the IRA of LUCs for IWGW, and ADEM concurs.

1.3 Assessment of the Site

The response action selected in this IROD is necessary for the continued protection of public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Currently, a site access control (SAC) program implemented by the Army ensures that the groundwater is properly controlled and managed for any current and future potable and nonpotable uses to prevent unacceptable human exposure. The Army, in conjunction with EPA and ADEM, has determined that a legally enforceable IRA is necessary for groundwater since a preliminary evaluation of chemical concentrations found in groundwater indicates there could be significant risks or hazards to human health if groundwater in some locations was used for potable water purposes before final remedies for the groundwater sites are instituted.

1.4 Description of the Selected Remedy

The Selected Remedy addresses the IWGW at Redstone Arsenal. The Army and EPA have determined that LUCs are appropriate for the groundwater. In order to address and mitigate potential risks or hazards to human health, the IRA will address and manage the groundwater ingestion pathway for current and future groundwater exposure. Groundwater monitoring is not part of the IRA remedy because the groundwater will be sampled and analyzed in future remedial investigations (RI) for groundwater and surface media sites. Surface media include surface soil, subsurface soil, sediment, surface water, and soil vapor as applicable. Appendix A contains a glossary of terms used in this IROD.

An LUC Remedial Design (RD) document will be prepared as the land use component of the RD. Within 90 days of IROD signature, the Army shall prepare and submit to EPA and ADEM for review and approval a LUC RD that shall contain implementation and maintenance actions. The following LUC objectives have been established for this IROD.

- Prohibit the use of groundwater at the Arsenal for drinking water purposes (including seeps and springs).
- Control the use of Arsenal groundwater for nonpotable uses in support of the Army's mission.
- Initiate formal coordination with local government agencies who may conduct activities on or off the Arsenal involving potentially contaminated groundwater where the Army is not in control of the action. This objective is to allow consistent review and input by the Army of pending groundwater actions to protect human health.

The bordering government entities with Redstone Arsenal are Madison County, the cities of Madison and Huntsville, and Morgan County (Figure 1). The town of Triana is located approximately one-half mile from the western boundary of Redstone Arsenal and will be included in formal coordination activities as well (Figure 1). On the Arsenal, government entities include the Tennessee Valley Authority and the U.S. Fish and Wildlife Service-Wheeler National Wildlife Refuge. The National Aeronautics and Space Administration (NASA) will implement their own IRA for groundwater under the George C. Marshall Space Flight Center (MSFC).

1.5 Statutory Determinations

The selected interim remedy (1) is protective of human health and is intended to provide adequate protection until the final RODs are signed for the groundwater sites; (2) complies with federal and state requirements that are applicable or relevant and appropriate for this limited scope action; and (3) is cost effective. This action is an interim solution only, and will not result in protection of the environment or utilize permanent and alternative treatment technologies to the maximum extent practicable for groundwater. This action will meet all applicable or relevant and appropriate requirements (ARAR) specifically associated with this limited scope. The final actions at the groundwater sites in combination with this interim action will either achieve compliance with all ARARs or will provide grounds for invoking a waiver under §300.430(f)(1)(ii)(C) of the NCP.

Because this remedy will result in hazardous substances remaining on site above levels that allow for unlimited use and unrestricted exposure, a review will be conducted to ensure that the remedy continues to provide adequate protection of human health within five years of commencement of the IRA. Because this is an IROD, review of groundwater will be ongoing as the Army continues to develop permanent solutions for the groundwater.

1.6 Interim Record of Decision Data Certification Checklist

The following information is included in the Decision Summary (Chapter 2.0) of this IROD. Additional information can be found in the Administrative Record file.

- Contaminants in the groundwater and their respective concentrations (see Sections 2.5 and 2.7)
- Streamlined human health risk evaluation (see Section 2.7)

- How source materials constituting principal threats are addressed (see Section 2.11)
- Current and reasonably anticipated future land-use assumptions and current and potential future beneficial uses of groundwater (see Section 2.6)
- Potential land and groundwater uses that will be available at the site as a result of the selected IRA (see Section 2.6)
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (see Section 2.12 and Table 18)
- Key decision factor(s) that led to selecting the interim remedy (see Sections 2.9 and 2.10).

1.7 Authorizing Signatures

This IROD documents the selected IRA for IWGW at Redstone Arsenal. The IRA was selected by the Army and EPA Region 4, with concurrence by ADEM.

11 Sep 07
John A. Olshefski Date
Colonel, US Army
Garrison Commander

9/24/07
Franklin E. Hill, Director Date
Superfund Division
U.S. Environmental Protection Agency, Region 4

Concurrence:

9/21/07
Wm. Gerald Hardy, Chief Date
Land Division
Alabama Department of Environmental Management

2.0 Decision Summary

2.1 Site Name, Location, and Description

Installation-Wide Groundwater
Redstone Arsenal
Madison County, Alabama

CERCLA Identification Number: AL7 210 020 742
Lead Agency: U.S. Army Garrison - Redstone

Redstone Arsenal is bordered by four local government entities as shown on Figure 1. The city of Huntsville and Madison County surround Redstone Arsenal to the north, east, and west. The city of Madison is adjacent to a very small portion of the northwest corner of the Arsenal. Morgan County lies south of the Arsenal across the Tennessee River. Additionally, the town of Triana is located approximately one-half mile from the western boundary of Redstone Arsenal.

2.2 Site History and Enforcement Activities

This section summarizes the site activities and investigations conducted at Redstone Arsenal and the enforcement history.

2.2.1 History of Site Activities

Redstone Arsenal is a U.S. Army facility that encompasses approximately 38,300 acres of land, all of which are either owned or controlled by the Army. Development within Redstone Arsenal has largely revolved around the historical need to produce (and later dispose of) conventional and chemical munitions and, more recently, to develop and test missiles and rockets. Production of chemical wastes has been the result of these processes since operations began in the early 1940s. Redstone Arsenal is composed of the Wheeler National Wildlife Refuge, operated by the U.S. Fish and Wildlife Service, to the south; industrial areas in the southeast; administrative facilities at the NASA's MSFC in the central portion; and family housing and commercial, recreational, and medical centers in the north portion. The Tennessee Valley Authority owns land to the south along the Tennessee River. Missile/rocket testing and munitions storage, along with the associated range fans, test area safety fans, and explosive safety-quantity distance arcs, have been reserved for the southern portion of Redstone Arsenal.

The primary mission of the Arsenal is the development, acquisition, testing, fielding, and sustainment of aviation and missile weapon systems. Most of the Redstone Arsenal tenants support the aviation and missile weapon system effort. Redstone Arsenal is also home to other

activities, such as handling explosives and ordnance devices, Defense Intelligence Agency activities, and the production of iron carbonyl. Redstone Arsenal is currently planning for the Army's Base Realignment and Closure (BRAC) targeted for 2011, which will bring building structure changes, expansion of missions, and current work force (civilian and military) growth.

2.2.2 History of Compliance Activities

The Army currently manages hazardous waste materials that are regulated under the Resource Conservation and Recovery Act (RCRA), a comprehensive law requiring owners and operators to manage hazardous waste in a responsible manner. Regulations under RCRA have made current owners and operators of treatment, storage, and/or disposal facilities accountable for following waste management regulations at operating facilities. A RCRA facility assessment was conducted at Redstone Arsenal in the late 1980s and sites were assigned as solid waste management units (SWMU) and areas of concern under RCRA Section 3004 (u) (A.T. Kearney, 1989; Geraghty & Miller, Inc., 1991). Redstone Arsenal currently operates under a RCRA Part B permit (issued April 15, 1998 and subsequent amendments September 17, 2003 and January 11, 2006). Corrective action requirements for SWMUs were incorporated into the permit. EPA named Redstone Arsenal to the National Priorities List on June 30, 1994, requiring the Army to follow CERCLA requirements. CERCLA was enacted in 1980 and later modified in 1986 to clean up sites from past waste management practices that have resulted in site media contamination. Because the Army must follow CERCLA as well as RCRA requirements in accordance with corrective action and closeout of the CERCLA sites listed on the Redstone Arsenal RCRA Part B permit, the Army has attempted to integrate both environmental programs in a focused approach to avoid duplication of effort.

Currently, 134 active surface media sites are being addressed under CERCLA/RCRA and 50 sites are being addressed under RCRA in the Army's Installation Restoration Program (IRP). An additional 13 groundwater sites are being added to the RCRA Part B permit as CERCLA sites at Redstone Arsenal. All of the CERCLA and RCRA sites are organized into 20 operable units (OU), primarily for administrative purposes for the Administrative Record. Figure 2 shows the 20 OUs at Redstone Arsenal and the locations for the various RCRA and CERCLA sites. The Army is focusing its immediate investigation and cleanup efforts on those surface media and groundwater sites that are considered "high" or "medium" risk as determined from a relative risk ranking evaluation based on human health and the environment.

The Army is working to meet remediation in place/response complete goals set by the U.S. Department of Defense for IRP sites in accordance with the procedures and requirements established in the Relative Risk Site Evaluation Primer. The relative risk scoring system (high,

medium, low) is based on comparison of site data to risk screening levels and evaluation of potential exposure pathways. Signature on the RSA-057, RSA-049, and RSA-011 surface media RODs are goals the Army is trying to meet by September 30, 2007.

In 2003, the Army began implementation of a SAC program in response to Redstone Arsenal Regulation 200-7. The SAC program established an access control program for the hazardous waste sites at Redstone Arsenal to protect workers and visitors (including recreational users who may enter the Arsenal for hunting and other activities), prevent spread of contamination, and aid in future cleanup (Army, 2006a). This program has been successfully implemented by the Army for several years and provides clearly defined roles and responsibilities, engineered controls (e.g., fencing and warning signs), and administrative controls (e.g., procedures, training, points of contact) for the installation restoration sites at Redstone Arsenal. The main components of the SAC program include the following:

- Review of job requests for construction and maintenance activities to ensure worker safety and compliance (including proposed activities that may encounter or withdraw groundwater)
- Maintenance and inspection of site access controls to protect against unauthorized entry
- Maintenance of information systems to update the site hazard ranking and required controls
- Ensuring no wells are installed on the Arsenal for drinking water purposes
- Maintenance of site maps with boundaries
- Coordination of current and future land use with the Base Master Planning organization (Army, 2006b)
- Protection of workers and visitors at CERCLA sites.

This SAC program is an internal Army program to address Redstone Arsenal Regulation 200-7. The SAC program is not a legally enforceable program, which has been a significant concern for ADEM. Hence, ADEM has initiated the request that this IROD be prepared to prevent potable use of groundwater at Redstone Arsenal and to manage nonpotable uses.

2.2.3 History of CERCLA Investigative Activities

Fulfilling the mission of Redstone Arsenal has resulted in the use of a wide range of toxic and hazardous substances, including chemical agents; industrial solvents; paints; photographic

chemicals; electroplating chemicals; propellants; oils contaminated with polychlorinated biphenyls (PCB); pesticides; liquid caustics; and a variety of fuels, oils, lubricants, and other waste products. Hazardous wastes from operations at Redstone Arsenal have historically been discharged to land through burial pits, burn pits, trenches, landfills, lagoons, waste ponds, and leaking aboveground or underground storage areas. These waste disposal practices began in the 1940s-1950s and were generally discontinued by the 1970s-1980s.

The Army is continuing to investigate the CERCLA surface media sites at Redstone Arsenal as the lead agency. The Army has been conducting investigations since the late 1970s/early 1980s to determine if soil and groundwater have been impacted by former Army operations. By the 1990s, soil and groundwater contamination was confirmed in many of the industrial areas of the Arsenal. In 1999, the Army began testing groundwater off the Arsenal to the east-southeast and confirmed that low concentrations of trichloroethene (TCE) had migrated off post from former degreasing operations in the OU-10/RSA-146 area. By 2001, the Army began analyzing off post groundwater for perchlorate, an emerging contaminant of concern from the former use of solid rocket propellants. Contaminant concentrations off post are presented in the RSA-146 Phase I RI report (Shaw, 2005). Volatile organic compounds (VOC) and perchlorate are present at levels that exceed risk-based screening levels and were identified as contaminants of concern in the preliminary risk assessment for exposure to off-site groundwater. However, the groundwater under the Arsenal and within the off-post portion of the plume originating from RSA-146 is not used for drinking water.

Upon completion of the surface media investigations to determine the nature and extent of contamination as well as to evaluate potential remedial technologies, the Army is preparing PPs and RODs for closeout of these surface media sites. The Army is also preparing to initiate or already conducting investigations and evaluations of the 13 identified groundwater sites at the Arsenal (Figure 2). The groundwater investigation is currently ongoing for RSA-146 (Shaw, 2005) and the others are planned to be initiated within the next three years. Table 1 presents the schedule for completion of the RI, feasibility study (FS), PP, and ROD for each of the groundwater sites.

Table 1. Risk Ranking and Schedules for the Groundwater Sites

Groundwater Site	Relative Risk Ranking	RI/FS/PP/ROD*	Projected Date for ROD Signature*
RSA-145	Medium	2007-2010	2010
RSA-146	High	2004-2010	2010
RSA-147	Medium	2008-2011	2011
RSA-148	Medium	2008-2011	2011

Groundwater Site	Relative Risk Ranking	RI/FS/PP/ROD*	Projected Date for ROD Signature*
RSA-149	Medium	2008-2011	2011
RSA-150	Low	2009-2012	2012
RSA-151	Medium	2008-2011	2011
RSA-152	Low	2008-2011	2011
RSA-153	Low	2009-2012	2012
RSA-154	Low	2010-2013	2013
RSA-155	Low	2009-2012	2012
RSA-156	Low	2010-2013	2013
RSA-157	Low	2010-2013	2013

*Dates are estimated and dependant upon Army funding.
FS - Feasibility study. RI - Remedial investigation.
PP - Proposed Plan. ROD - Record of Decision.

2.2.4 History of CERCLA Enforcement Activities

No CERCLA enforcement activities have been conducted for groundwater at Redstone Arsenal. Since the 1970s, the Army has acted voluntarily to investigate the groundwater. Many investigations have been conducted to date under the Army's IRP to determine the nature and extent of groundwater contamination.

2.3 Community Participation

The Army offers several opportunities for members of the public to become involved in the environmental cleanup and land-use decision-making processes at Redstone Arsenal, consistent with its public participation responsibilities under Sections 113 (k)(2)(b), 117(a), and 121(f)(1)(g) of CERCLA and ADEM 335-14-8-.04 for permit modifications under RCRA. These opportunities include the following:

- ***Administrative Record File and Information Repositories.*** The Administrative Record file contains all the documentation the Army considered in selecting each site remedy. Documents in the Administrative Record file for IWGW and the individual surface media and groundwater sites at Redstone Arsenal can be found at the information repositories maintained at the following locations:

Location:	Redstone Arsenal, Environmental Management Division, Building 4488, Martin Road, Room A327
Contact:	Ms. Salee Sloan (256) 842-0314
Business Hours:	Monday – Friday 7:00 a.m. – 4:30 p.m. Central Time Zone
Location:	Triana Public Library (Triana Youth Center), Triana
Contact:	Ms. Wendy Qualls (256) 772-3677
Business Hours:	Monday – Friday 11:30 a.m. – 6:00 p.m. and First and Third Saturdays 12:00 p.m. – 5 p.m. Central Time Zone

Location:	Huntsville/Madison County Public Library Heritage Room, 915 Monroe Street, Huntsville
Contact:	Ms. Anne Fuller (256) 532-5969
Business Hours:	Monday – Thursday 9:00 a.m. – 9:00 p.m., Friday – Saturday 9:00 a.m. – 5:00 p.m., and Sunday 1:00 p.m. – 5:00 p.m. Central Time Zone

Documents covering the investigation of CERCLA sites including groundwater can also be obtained on line from the Redstone Arsenal web site: www.environmental.redstone.army.mil under "Archived Documents."

- ***Community Relations Plan.*** A Community Relations Plan (Shaw, 2006) has been published to keep the community informed of cleanup progress at Redstone Arsenal and to provide opportunities for the public to interact with the Army. This plan, which includes interviews with community members, is reviewed and updated, as necessary, on an annual basis.

- ***Fact Sheets.*** Informational materials, such as fact sheets, are made available to community members on an ongoing basis through periodic mailings and public meetings. These fact sheets are also available on the Redstone Arsenal environmental web site.

- ***Mailing List.*** A mailing list of community members and individuals that have requested information is maintained by the Army. This list is used for distribution of periodic information pertaining to the IRP.

- ***Open Houses/Informational Meetings.*** Informational meetings on the status of IRP efforts at the Arsenal have been held every couple of years, more frequently when events have required it. These meetings have been publicized by the local media. The meetings are used to answer the public's concerns and to update local citizens on the progress of the Army's investigations and cleanup actions.

- ***Press Releases.*** Press releases to local Huntsville newspapers have been issued on an as-needed basis for activities, decisions, updates, and milestones associated with the cleanup effort. In addition, environmental subjects are periodically published in the Base newspaper, the *Redstone Rocket*, which is available to all workers and visitors to the Arsenal.

The final PP (Shaw, 2007) was released in July 2007 for public review and comment. A notice of availability of the IWGW PP was published in *The Huntsville Times* on July 22, 2007 and July 25, 2007; in the *Speakin' Out News* on July 25, 2007; and in the *Redstone Rocket* on July 25, 2007. A 30-day public comment period on the PP began on July 22, 2007. The PP stated that a public meeting would be held if there was sufficient interest from the public. A meeting was not requested and the public comment period ended on August 20, 2007. No comments were received during the public comment period.

2.4 Scope and Role of the Response Action

This section includes the rationale for undertaking the IRA for the IWGW, the scope and role of the response action for the IWGW within the overall cleanup strategy for Redstone Arsenal, and a description of the consistency between the IRA for IWGW and future remedial actions for groundwater.

2.4.1 Rationale for Undertaking this IRA at Redstone Arsenal

During the regulatory reviews of recently prepared surface media RODs, ADEM indicated to the Army that it will not concur because of the lack of state regulatory enforcement control over the potential exposure route for human receptors who may unknowingly drink the contaminated groundwater under the surface media sites. The surface media RODs select remedies for surface media at this time and defer decisions on the groundwater to the groundwater sites. Remedy selection for the groundwater sites will be made following completion of each RI/FS as noted in Table 1. The RSA-099 (Redstone Arsenal Site RSA-099, Abandoned Plating Shop Tanks and Sump, Building 7614) surface media ROD for No Action was signed by EPA Region 4 and the Army in 2004 (Shaw, 2004) but ADEM declined to sign in concurrence based upon its position on groundwater. The finalization and regulatory concurrence on the RSA-057 (Redstone Arsenal Site RSA-057, Inactive Arsenic Waste Lagoons – East) surface media ROD and others are currently awaiting significant Army progress on this IROD.

In order to address ADEM's concern over exposure to groundwater under the CERCLA surface media sites, EPA Region 4, ADEM, and the Army agreed on June 21-22, 2006 to the following path forward:

- An IROD will be developed to prevent potable use and provide management control over nonpotable uses of all groundwater beneath the Arsenal.
- An RD document will be developed to specify details concerning the implementation of the IWGW interim LUCs.
- The IROD will remain in effect until such time as the final remedies are selected for each groundwater site.
- As final groundwater site RODs are completed, any final LUCs in those RODs will supersede the interim LUCs contained in this IWGW IROD.

This path forward recognizes that an IRA may be needed even before enough information can be gathered to prepare final RODs for the groundwater sites. To fill this need, EPA encourages the

use of IRAs so that as many remedial action decisions as possible can occur at the earliest point in the site investigations. The NCP [§300.430(a)(1)(iii)(D)] recognizes LUCs as alternatives to short-and long-term site management to prevent or limit exposure to hazardous substances, pollutants, or contaminants. Since LUCs are expected to be a component of the final remedy(s) for the groundwater sites, the Army, EPA Region 4, and ADEM agreed to implement LUCs as an interim action for IWGW.

The decision documents are supported by the Administrative Record in general and by the various CERCLA steps taken at the surface media sites on the Arsenal in particular. This IROD is supported by the findings from investigations of groundwater during surface media investigations conducted to date throughout the Arsenal and from the Phase I RI for the RSA-146 groundwater site (Shaw, 2005).

2.4.2 Scope of the Groundwater IRA within the Site Strategy

The scope of the problem to be addressed by this IRA is to provide LUCs for IWGW to protect current and future human health prior to implementation of a final groundwater remedy. This includes ensuring that Redstone's groundwater is not used for drinking water in the interim and that current and future nonpotable uses of the groundwater are managed to prevent human consumption and to control other types of exposures.

This IROD covers the entire Arsenal (fence to fence) with the exception of the NASA MSFC area (Figure 2). The groundwater under the MSFC portion of Redstone Arsenal is not part of the scope of this document. MSFC is located near the central portion of the Arsenal. Although the groundwater underlying MSFC is technically inseparable from the rest of the Arsenal groundwater, NASA is developing a separate IRA PP and IROD to address similar risks from contaminated groundwater (i.e., OU-3) under its portion of the Arsenal. Thus, implementation of this IRA will involve a multi-party decision-making process among the Army, NASA, EPA Region 4, and ADEM. This action also only applies to the groundwater within the control of the Army. The Army does not have authority to enforce LUCs off the Arsenal. The anticipated mechanisms for ensuring protection from off-site migration of groundwater contamination are discussed in Sections 2.8 and 2.9.2 of this IROD.

The following are not part of the scope addressed by this IWGW IRA at Redstone:

- Groundwater monitoring (sampling and analysis). Groundwater monitoring is being implemented separately in future RIs for each groundwater, and surface media site and in other programs. Additional groundwater monitoring is, therefore, not a component of this IRA. Available data are sufficient to justify the

need for interim LUCs to restrict groundwater use and exposures on the Arsenal. Long-term groundwater monitoring of the groundwater sites is anticipated to be part of the final remedy for the groundwater sites.

- Control of vapors emanating from groundwater plumes. Human health exposure to vapors from VOCs in groundwater that can migrate into buildings is currently being addressed with the specific surface media sites and will be addressed in association with the groundwater sites as well.
- Protection of the environment.
- Remediation of contaminated groundwater.
- Control of groundwater plume migration on and off the Arsenal.
- Protection of downgradient surface water resources.

This action will meet all ARARs specifically associated with this interim action. The final action at the groundwater sites in combination with this IRA will either achieve compliance with all ARARs or will provide grounds for invoking a waiver under §300.430(f)(1)(ii)(C) of the NCP. ARARs compliance for surface water or groundwater will be addressed in the final action for each surface media or groundwater site. Final remedies for groundwater are expected to involve active remediation to clean up the contaminant plumes where technically feasible and may also involve LUCs and passive remediation such as natural attenuation. The final groundwater RODs will supersede this IWGW IROD.

2.4.3 *Role of the Response Action in the Overall Cleanup Strategy for Redstone Arsenal*

Thirteen groundwater sites have been identified at Redstone Arsenal, and contamination is present at all of the groundwater sites at varying degrees. Because it will require several years to complete the RI/FS at each groundwater site and receive a signed ROD, the focus of this IROD is to provide protection for human receptors from ingestion of contaminated groundwater in the interim.

The groundwater site RIs are planned to be completed in the next several years. Their scheduled dates are based on the relative risk ranking of the groundwater sites (Table 1). This IWGW IROD will be reviewed at a minimum of five-year intervals, and groundwater site schedules will also be revisited at that time.

2.4.4 Consistency of this Groundwater IRA with Future Actions at Redstone Arsenal

This IRA is an interim decision for IWGW. An LUC RD document will be developed following signature of this IROD to specify the details concerning the implementation of LUCs for the IWGW. Appendix B contains a completed checklist used by EPA for RODs and IRODs that contain LUCs. This completed checklist provides a cross reference between this IROD and EPA's requirements for documenting LUCs in an IROD. Although this IRA is expected to provide protection to human health in the interim, a final remedy will be developed and documented in a ROD for each groundwater site to address remedy evaluation criteria not currently addressed by this interim action. This IROD will remain in effect until such time as each groundwater ROD is finalized. Final remedies will also be developed as needed for Integrator OUs (surface water bodies, wetlands, and floodplains where contamination from multiple sources has become collocated) to address potential risks posed by groundwater discharges to the environment.

A variety of innovative treatment technologies will be evaluated as part of the FS for groundwater sites as needed. Treatability studies may be conducted to assist in the selection of innovative technologies as part of the final remedy. Other IRAs may be conducted for groundwater to address specific contamination or plume locations before proceeding with the final RODs for the groundwater sites. It is expected that this IRA will be consistent with other interim or final RODs that will be developed.

2.5 Site Characteristics

This section summarizes the site characteristics, including hydrogeologic conditions, contaminants of concern, extent of contamination, and data gaps, for the IWGW at Redstone Arsenal.

Hydrogeologic Conditions. Redstone Arsenal is underlain by carbonate bedrock (primarily limestone), and karst features (enlarged joints, bedding planes, and other water-transmitting openings) of varying scales have been noted during CERCLA investigations at Redstone Arsenal. The subsurface environment beneath the Arsenal consists of a clayey overburden underlain by limestone bedrock. The overburden was formed by the natural weathering of the underlying fractured limestone bedrock. The limestone bedrock has been unevenly weathered to form karst features that influence movement of groundwater. Groundwater flow and contaminant transport in a karst setting is highly complex. The groundwater often travels quickly over long distances and discharges to seeps and springs across the Arsenal. The depth to

groundwater is highly variable, ranging from a few feet below the ground surface in low-lying areas of the Arsenal to greater depths in higher elevations.

An installation-wide hydrogeological study ("Karst Study") was initiated at Redstone Arsenal in 1999, which documented the very complex and highly interconnected nature of groundwater at the Arsenal and the potential for rapid and long distance contaminant transport (IT Corporation, 2003). Based on this Karst Study, it was determined that groundwater flow and contaminant transport at Redstone Arsenal occurs within three large north-south oriented karst watersheds (Figure 3). Groundwater flow enters the Arsenal along the northern boundary, flowing south toward the Tennessee River within the three watersheds. Local groundwater divides exist within these 3 watersheds, subdividing the groundwater further into 13 discrete units. These 13 sub-watersheds form the basis for the assignment of 13 groundwater sites at Redstone Arsenal (RSA-145 through RSA-157) (Figure 2).

Because groundwater flowpaths within a watershed are long, originating off post in some cases and extend beyond individual site boundaries, groundwater plumes from specific sources in an area often merge or commingle. Therefore, a decision was made by the Army, in conjunction with EPA Region 4 and ADEM, to separate surface media from groundwater for the purpose of remediation. This decision allows a more focused interpretation of surface media contaminants by addressing human health or ecological risks from surface soil or sediment exposure pathways and from source material that may contaminate groundwater locally or at a distance. An integrated, watershed approach to groundwater characterization and cleanup is important to ensure sources to groundwater are identified and remediated, and in a sequence that leads to improved groundwater quality within the watershed. Once current and ongoing sources are stopped, remediation of groundwater can be addressed. Table 2 presents the 13 groundwater sites, their surface OU locations, typical historical activities, and contaminants detected in groundwater. Table 1 presents the schedule for remediation.

Table 2. Summary of History and Contaminants at Groundwater Sites

Groundwater Site	Surface OUs	Historical Activities	Groundwater Contaminants
RSA-145	All of OU-1 and 2, most of OU-3, and parts of OU-6, 7, and 19	Smoke munitions and incendiary bomb production, administrative support, training, test range	VOCs, SVOCs, explosives, pesticides, and perchlorate
RSA-146	All of OU-9 and 11, most of OU-10 and 12, and parts of OU-7 and 20	Solid rocket propellant development and testing for missiles and rockets; ordnance assembly, storage, and loading; reconditioning of ammunition returned from overseas	VOCs, SVOCs, metals, explosives, pesticides, PCBs, and perchlorate

Groundwater Site	Surface OUs	Historical Activities	Groundwater Contaminants
RSA-147	Parts of OU-3, 4, 6, and 7	Chemical warfare manufacture (mustard and lewisite), DDT manufacture, chlorine production	VOCs, SVOCs, metals, explosives, pesticides, and PCBs
RSA-148	Most of OU-4 and 5, and parts of OU-3, 6, 7, 8, 18, and 19	Chemical warfare manufacture (mustard and lewisite), chlorine production	VOCs, SVOCs, metals, explosives, pesticides, PCBs, and perchlorate
RSA-149	Most of OU-18 and parts of OU-5, 8, 17, 19, and 20	Aerospace development, chemical munitions disposal, surplus materials salvage	VOCs, SVOCs, and pesticides
RSA-150	All of OU-16 and parts of OU-3, 17, 19, and 20	Test ranges and troop training areas	VOCs, SVOCs, and explosives
RSA-151	Most of OU-14 and part of OU-15	Open-burning/open-detonation operations	VOCs, SVOCs, explosives, and perchlorate
RSA-152	Most of OU-15 and part of OU-20	Gulf Chemical Warfare Depot for storage and disposal of chemical warfare material and other chemicals	VOCs, SVOCs, and explosives
RSA-153	Parts of OU-17, 19, and 20	Test ranges	VOCs, SVOCs, and metals
RSA-154	Parts of OU-10, 12, 17, and 20	Test ranges, warehouse storage	VOCs, SVOCs, explosives, and perchlorate
RSA-155	Parts of OU-17 and 20	Dock off-loading, test range	VOCs and SVOCs
RSA-156	Most of OU-13 and parts of OU-14, 15, and 20	Storage of raw materials, finished munitions, and miscellaneous materials for the Gulf Chemical Warfare Depot	VOCs, explosives, and perchlorate
RSA-157	Parts of OU-12, 13, and 20	Storage of raw materials, finished munitions, and miscellaneous materials for the Gulf Chemical Warfare Depot	VOCs, metals, and explosives

DDT – Dichlorodiphenyltrichloroethane.
PCB – Polychlorinated biphenyl.
SVOC – Semivolatile organic compound.
VOC – Volatile organic compound.

Contaminants of Concern. VOCs, including TCE, have been used historically at Redstone Arsenal as a solvent for degreasing and cleaning parts during industrial operations and are present in groundwater. TCE concentration in groundwater ranges from nondetect in remote parts of the Arsenal up to 1,500,000 micrograms per liter (µg/L) in RSA-146. Fuel-related compounds such as benzene and toluene have been detected in groundwater from past service station leaks and leaks from petroleum-containing underground and aboveground storage tanks. Nitroaromatic compounds (i.e., explosives) and semivolatile organic compounds (SVOC) have been detected in most of the groundwater sites from the historical activities with munitions production. Ammonium perchlorate use in the manufacture, use, and disposal of rocket motor propellant has resulted in elevated concentrations of perchlorate in several of the groundwater sites. Metals are naturally occurring in the environment, but historical operations have resulted in concentrations of a few metals exceeding the naturally occurring background levels in

groundwater. The manufacture of dichlorodiphenyltrichloroethane (DDT) at Redstone Arsenal has resulted in elevated levels in site media, including groundwater in several groundwater sites.

Contaminants released to the soil that have migrated down to groundwater have the potential to move long distances away from the point of release and may, in some instances, resurface at one or more of the springs/seeps located both on and off the Arsenal. Surface media investigations evaluate the potential for contamination in soils to leach to groundwater. Potential risks to human health and the environment from direct or indirect contact with surface media contaminants are evaluated as well. In the course of conducting the surface media RIs, it has been found that groundwater contamination often extends beyond the boundary of a surface media site. The contamination often extends under several sites and contaminant plumes from multiple sources are often commingled. Thus, the Army has developed a more comprehensive approach to groundwater investigation and remediation at Redstone Arsenal. Concurrent with the ongoing surface media investigations at the individual CERCLA sites, the 13 groundwater sites will also be investigated.

Extent of Contamination. Groundwater investigations have been conducted in several locations throughout the Arsenal, including around the perimeter, within RSA-146, at the surface media investigations at the various RCRA and CERCLA sites, and at potential source area sites. Further investigations to complete the groundwater site RIs are planned per the schedule in Table 1. One groundwater site, RSA-146, has a high relative risk ranking since it is one of the most contaminated portions of the Arsenal (southeast corner; see Figure 2). Investigations to date in RSA-146 have determined that the groundwater is contaminated with high concentrations of perchlorate and VOCs from chlorinated solvents which are often commingled. The Army previously installed two temporary pump and treat systems at RSA-146 and has been conducting treatability studies to evaluate remedial technologies for the TCE groundwater contamination that may be applicable to remediating the RSA-146 groundwater (Army, 2005a).

Contamination found in the RSA-146 groundwater is known to have migrated off post along the southeastern boundary of the Arsenal under land within the city of Huntsville and portions of Madison County (Figure 1). The Army continues to monitor and evaluate this off-post plume containing low concentrations of primarily TCE and perchlorate (Shaw, 2005; Army, 2005a, and b). The Army has determined that contaminated groundwater is well below the ground surface and is not directly under any current homes. Off-post residents receive their drinking water from Huntsville Utilities. The water has been treated at treatment plants to provide drinking water that meets safe drinking water standards as required by the EPA (Huntsville Utilities, 2006). Based on this information, current exposure by off-post residents to contamination in groundwater is

not occurring, but residents could be exposed to contaminants within this plume if private drinking water wells were allowed.

Although groundwater evaluations for the groundwater site (RSA-153) adjacent to the city of Madison are not yet complete, available data do not indicate that plumes of contaminated groundwater originating from Redstone Arsenal are present at this site and no plumes are leaving the Arsenal in this area. Similarly, the Army recently initiated a groundwater sampling effort in Morgan County to address the possibility that groundwater plumes from Redstone Arsenal have traveled underneath the Tennessee River and into this county. As an initial step, residential wells and springs were sampled to assess whether anyone was potentially exposed to contaminated groundwater from Redstone Arsenal. The sampling results do not indicate that contamination originating from the Arsenal is present in these wells or that there is unacceptable risk from exposure to groundwater from these wells and springs.

Data also indicates that contamination from off-post sources may be impacting groundwater and surface water quality on Redstone Arsenal. A series of perimeter wells is currently being installed to help identify if contamination from off-site sources may be entering the Arsenal at specific locations, including on the northern boundary.

Section 2.8 presents an interim remedial action objective (IRAO) where the Army will develop formal mechanisms to coordinate with adjacent government entities to review proposed off-post groundwater uses that are beyond the Army's control. This review process will serve to protect the community from inadvertent ingestion or other exposure to contaminated groundwater beneath areas immediately outside the Arsenal boundary.

Data Gaps. Principal data gaps include potential contaminant leaching from specific source areas to groundwater, the lateral and vertical extent of contaminant plumes in the individual groundwater sites, and specific contaminant plumes coming onto the Arsenal. Table 1 presents the schedule for completion of the investigations to address these data gaps in the RI for each groundwater site.

2.6 Current and Potential Future Land and Resources Use

2.6.1 Current and Future Land Use

Current Land Use. The current land use at Redstone Arsenal has not changed much over the last 20 years in patterns or categories (Army, 2006b). The majority of land use is in the

following categories: test ranges, manufacturing/production, and training. Figure 4 shows the current land use at Redstone Arsenal with corresponding acreages. Land near the central portion of the Arsenal is leased to NASA. Off-post land use to the east-southeast of the Arsenal, where contaminated groundwater has migrated, is zoned for residential use within the city of Huntsville.

Future Land Use. The future land use for Redstone Arsenal is projected to retain the established land use categories and basic land area coverage (Army, 2006b). The most significant proposed change is conversion of the large testing range areas on the western portion of the Arsenal into Research, Development, Testing, and Engineering. Figure 5 shows the future land use planned at Redstone Arsenal and the assigned acreage. The Army's BRAC program at Redstone Arsenal will result in considerable new construction, including a 400-to 500-acre parcel in the northwest portion of the Arsenal planned for Enhanced Use Leasing. This area is currently used for pasture and farming. The complex will include offices, research and development facilities, and academic/conferencing facilities much like the current Sparkman Center at Redstone Arsenal. The first of the facilities is planned for opening by October 2008. Future land use for the area to the east-southeast of the Arsenal, where known groundwater contamination is present, is planned to remain residential within the city of Huntsville.

2.6.2 Groundwater Use

Current Groundwater Use. The groundwater is not currently used as potable water on the Arsenal. Arsenal workers and on-post residents and residents of Madison County receive their potable water from Huntsville Utilities, where the water is derived from the Tennessee River. The Army currently allows managed use of groundwater for nonpotable purposes, including watering a golf course, washing vehicles, and use in remote restrooms (Figure 6). Remote restrooms contain signs stating that the water is contaminated and should not be consumed. Bottled water is provided at these locations, and workers have been instructed not to consume the water. The Army also accesses groundwater on a temporary basis for construction and remediation purposes as well as for maintenance activities such as dewatering operations and sump maintenance.

Future Groundwater Use. It is not anticipated that groundwater resources at Redstone Arsenal will be developed in the future, and the Army is unlikely to change the current mission of Redstone Arsenal. However, in the unlikely event that the Army mission should change, which could prompt the need for use of the groundwater resources under the Arsenal, this IROD has been developed for IWGW to control and manage its use.

2.7 Site Risks

The RI/FS (including risk assessments) for the 13 groundwater sites under the Arsenal are either currently underway (RSA-146; Shaw, 2005) or in the planning stages. These investigations will determine the nature and extent of contamination in groundwater on a groundwater site-by-groundwater site basis and will form the basis for screening and evaluating potential remedial alternatives in the FS for the groundwater at each site.

EPA's Office of Solid Waste and Emergency Response directive entitled *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* specifies that IRAs do not require a completed baseline risk assessment (EPA, 1991). Interim actions may be taken to respond to an immediate site threat or to reduce risk quickly if warranted by site conditions. While a baseline risk assessment is not required, it is necessary to provide enough information to demonstrate the potential for risk in order to justify the need to take action. EPA (1999) specifies that this documentation should be presented in an interim action ROD to fulfill requirements of the Administrative Record.

A streamlined risk evaluation has been performed in support of the IWGW IRA to demonstrate that there is a potential for unacceptable risk to human receptors from exposure to contaminants in groundwater if exposure to groundwater is not prevented or managed. This streamlined risk evaluation applied an approach recommended by EPA Region 4 for use at both Redstone Arsenal and MSFC for this IRA and for other groundwater-related IRAs that are being performed at MSFC. In this streamlined human health risk evaluation, maximum groundwater concentrations were compared to EPA Region 9 preliminary remediation goals (PRG) for tap water (EPA, 2004) and to maximum contaminant levels (MCL) (EPA, 2006).

PRGs represent risk-based groundwater concentrations at risk thresholds equal to 1×10^{-6} (or a 1 in 1,000,000 chance of developing cancer from exposure to groundwater) or at a noncancer hazard index equal to 1. For PRGs based on noncancer endpoints, chronic exposure to concentrations greater than the PRG may result in adverse noncancer health effects. MCLs are not purely health based but may also be used to determine whether a site poses a threat at a level warranting action (EPA, 1991). Perchlorate has been identified as one of the Army's emerging contaminants of concern. EPA has developed a drinking water equivalency level (DWEL) of 24.5 µg/L for perchlorate. A DWEL, which assumes that all of a contaminant comes from drinking water, is the concentration of a contaminant in drinking water that will have no adverse effect with a margin of safety. Because there is a margin of safety built into the DWEL and into the toxicity values used to develop DWELs, exposure to groundwater concentrations greater than

the DWEL may also result in no adverse health effects. The Army uses a similar health-based screening value for perchlorate equal to 24 µg/L. In this streamlined risk evaluation, groundwater concentrations have been compared to the EPA DWEL for perchlorate to demonstrate that a potential for risk exists if exposure to this chemical in groundwater were to occur.

Concentrations of contaminants in groundwater were found to exceed PRGs or MCLs in all 13 groundwater sites, as shown in Tables 3 through 15. While EPA Region 9 guidance on PRGs specifies that these values are not *de facto* cleanup standards and should not be applied as such, exceedances of PRGs demonstrate that a potential for unacceptable risks exists. The magnitude and extent of this potential risk cannot be determined from this evaluation. However, some groundwater sites have significant concentrations of VOCs occurring over large areas.

MCLs for known site-related chemicals were also exceeded in all 13 groundwater sites, as shown in Tables 3 through 15. For sites where perchlorate was present, groundwater concentrations typically exceeded the EPA DWEL. These screening tables illustrate the large number and types of contaminants present in the groundwater. Some contaminants were only detected above the screening criteria at one monitoring well location and others had multiple exceedances of the screening criteria, indicating the presence of plumes of contaminants in the groundwater. As shown in the tables, the groundwater contaminant plumes largely consist of chlorinated VOC compounds, with TCE a frequently detected constituent occurring at elevated concentrations in the plumes. The IRA will not involve remediation of the groundwater to meet the MCLs; this comparison is presented to support the need for an IRA at this time. MCLs, as part of compliance with ARARs, will be met by this IRA in combination with the final action, or grounds will be provided for invoking a waiver under §300.430(f)(1)(ii)(C)(3) of the NCP.

Table 3. Contaminants Detected in RSA-145 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Explosives				
Nitroglycerin	70	4.8	NA	Yes
2-Nitrotoluene	0.36	0.05	NA	Yes
RDX	1.2	0.61	NA	Yes

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Pesticides				
Aldrin	0.01	0.004	NA	Yes
Alpha-BHC	0.11	0.01	NA	Yes
Beta-BHC	5.1	0.04	NA	Yes
4,4'-DDD	1.7	0.28	NA	Yes
4,4'-DDE	0.25	0.2	NA	Yes
Dieldrin	0.056	0.004	NA	Yes
SVOCs				
Benzo(a) anthracene	1.4	0.09	NA	Yes
Benzo(a) pyrene	1.2	0.009	0.2	Yes
bis (2-Chloroethyl)ether	6.6	0.01	NA	Yes
bis (2-Chloroisopropyl) ether	18	0.27	NA	Yes
Naphthalene	97	6.2	NA	Yes
4-Nitroaniline	17	3.2	NA	Yes
VOCs				
Benzene	7,800	0.35	5	Yes
2-Butanone	59,000	6,968	NA	Yes
Carbon tetrachloride	56	0.17	5	Yes
Chlorobenzene	12,000	106	100	Yes
Dibromochloromethane	25	0.13	80	No
1,2-Dichloroethane	260	0.12	5	Yes
1,1-Dichloroethene	2,000	339	7	Yes
1,2-Dichloroethene	350	NA	NA	No
cis-1,2-Dichloroethene	73	61	70	Yes
Ether, tert-butyl methyl	3,500	11	NA	Yes
Ethylbenzene	3,200	1,340	700	Yes
Methylene chloride	57	4.3	5	Yes
Tetrachloroethene	24	0.10	5	Yes
Toluene	5,500	723	1,000	Yes
Trichloroethylene	860	0.03	5	Yes
Vinyl chloride	360	0.02	2	Yes
Xylene (total)	11,000	206	10,000	Yes
Other				
Perchlorate	150	24.5	NA	Yes

[1]All chemical acronyms can be found in the Acronym List.

[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. For perchlorate, the EPA Drinking Water Equivalency Level was used. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.

[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.

[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.

NA – Not applicable.

µg/L – micrograms per liter.

Table 4. Contaminants Detected in RSA-146 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Metals[5]				
Cadmium	38	18.2	5	Yes
Explosives				
Nitrobenzene	6.1	3.4	NA	Yes
Nitroglycerin	9.8	4.8	NA	Yes
2-Nitrotoluene	0.74	0.05	NA	Yes
p-Nitrotoluene	0.96	0.66	NA	Yes
RDX	310	0.61	NA	Yes
Pesticides/PCBs				
Aldrin	0.052	0.004	NA	Yes
Aroclor 1248	1.6	0.5	NA	Yes
Dieldrin	0.064	0.004	NA	Yes
SVOCs				
Anthracene	18,000	1,825	NA	Yes
Benzo(a)anthracene	750	0.09	NA	Yes
Benzo(a)pyrene	1.2	0.009	0.2	Yes
Benzo(b)fluoranthene	1.8	0.09	NA	Yes
Carbazole	22	3.4	NA	Yes
Chrysene	770	9.2	NA	Yes
Dibenzofuran	23	12	NA	Yes
Fluorene	3,600	243	NA	Yes
Indeno(1,2,3-cd)pyrene	1.3	0.09	NA	Yes
Naphthalene	4,800	6.2	NA	Yes
4-Nitroaniline	9.3	3.2	NA	Yes
n-Nitrosodiphenylamine	41	14	NA	Yes
Pyrene	1,800	182	NA	Yes
VOCs				
Acetone	88,000	5,475	NA	Yes
Benzene	130	0.35	5	Yes
Bromodichloromethane	9,100	0.18	80	Yes
Bromomethane	83	8.7	NA	Yes
1,1,1-Trichloroethane	91,000	3,172	200	Yes
1,1,2,2-Tetracloroethane	950	0.06	NA	Yes
1,1,2-Trichloroethane	660	0.20	5	Yes
1,1-Dicloroethene	19,000	339	7	Yes
Cis-1,2-Dichloroethene	71,000	61	70	Yes
1,2-Dichloroethane	190	0.12	5	Yes
1,2-Dichloropropane	2,800	0.16	5	Yes
2-Butanone	260,000	6,968	NA	Yes
Carbon tetrachloride	26,000	0.17	5	Yes
Chlorobenzene	950	106	100	Yes
Chloroethane	92	4.6	NA	Yes
Chloroform	30,000	0.17	80	Yes
Chloromethane	640	158	NA	Yes
Cis-1,2-Dichloroethene	71,000	61	70	Yes
Dibromochloromethane	16	0.13	80	No
Methylene chloride	110,000	4.3	5	Yes

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Tetrachloroethene	1,600	0.10	5	Yes
Toluene	7,800	723	1,000	Yes
Trichloroethylene	1,500,000	0.03	5	Yes
Vinyl chloride	5,700	0.02	2	Yes
Other				
Perchlorate	220,000	24.5	NA	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. For perchlorate, the EPA Drinking Water Equivalency Level was used. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
[5]Metals may represent high turbidity in the sample and, therefore, not be representative of groundwater contamination.
NA – Not applicable.
µg/L – micrograms per liter.

Table 5. Contaminants Detected in RSA-147 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Metals[5]				
Arsenic	19,300	0.04	10	Yes
Barium	6,310	2,555	2,000	Yes
Chromium	263	NA	100	Yes
Lead	248	15	15	Yes
Explosives				
2-Nitrotoluene	0.88	0.05	NA	Yes
p-Nitrotoluene	1.3	0.66	NA	Yes
RDX	3.4	0.61	NA	Yes
Pesticides/PCBs				
Aroclor 1248	3.3	0.5	NA	Yes
Aroclor 1254	2.6	0.03	0.5	Yes
Aroclor 1260	1	0.03	0.5	Yes
Beta-BHC	0.06	0.04	NA	Yes
Chlordane, Technical	9.8	0.19	2	Yes
SVOCs				
Benzo(a)pyrene	1.2	0.009	0.2	Yes
Benzo(b)fluoranthene	0.61	0.09	NA	Yes
bis (2-Chloroethyl) ether	2.1	0.01	NA	Yes
bis (2-Ethylhexyl) phthalate	67	4.8	6	Yes
Hexachlorobutadiene	1	0.86	NA	Yes
4-Nitroaniline	10	3.2	NA	Yes

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
VOCs				
Acetone	13,000	5,475	NA	Yes
Benzene	13	0.35	5	Yes
Carbon tetrachloride	75	0.17	5	Yes
Chlorobenzene	1,400	106	100	Yes
Chloroform	570	0.17	80	Yes
Methylene chloride	17	4.3	5	Yes
1,1,2,2-Tetrachloroethane	160	0.06	NA	Yes
Tetrachloroethene	8	0.10	5	Yes
1,1,2-Trichloroethane	24	0.20	5	Yes
Trichloroethylene	4,300	0.03	5	Yes
Vinyl chloride	660	0.02	2	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
[5]Metals may represent high turbidity in the sample and, therefore, not be representative of groundwater contamination.
NA – Not applicable.
µg/L – micrograms per liter.

Table 6. Contaminants Detected in RSA-148 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Metals[5]				
Arsenic	24	0.04	10	Yes
Iron	51,000	10,950	NA	Yes
Explosives				
1,3-Dinitrobenzene	10	3.6	NA	Yes
2-Nitrotoluene	30	0.05	NA	Yes
p-Nitrotoluene	4.4	0.66	NA	Yes
RDX	12	0.61	NA	Yes
Pesticides/PCBs				
Aldrin	0.01	0.004	NA	Yes
Alpha-BHC	2.1	0.01	NA	Yes
Aroclor 1242	120	0.33	0.5	Yes
beta-BHC	3.2	0.04	NA	Yes
Dieldrin	0.07	0.004	NA	Yes
4,4'-DDD	480	0.28	NA	Yes
4,4'-DDE	250	0.2	NA	Yes
4,4'-DDT	1,200	0.2	NA	Yes
Gamma-BHC (Lindane)	2.8	0.05	0.2	Yes
Heptachlor	2.2	0.01	0.4	Yes

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
SVOCs				
Bis (2-Ethylhexyl)phthalate	140	4.8	6	Yes
Carbazole	28	3.4	NA	Yes
Hexachloroethane	8.2	4.8	NA	Yes
Naphthalene	100	6.2	NA	Yes
4-Nitroaniline	7.6	3.2	NA	Yes
VOCs				
Benzene	100	0.35	5	Yes
Carbon tetrachloride	110,000	0.17	5	Yes
Chlorobenzene	130,000	106	106	Yes
Chloroform	41,000	0.17	80	Yes
Chloromethane	23	158	NA	No
1,2-Dichloroethane	56	0.12	5	Yes
1,1-Dichloroethene	620	339	7	Yes
1,2-Dichloroethene	1,800	NA	NA	No
1,2-Dichloropropane	5.6	0.16	5	Yes
Methylene chloride	48,000	4.3	5	Yes
Tetrachloroethene	240	0.10	5	Yes
1,1,2,2-Tetrachloroethane	4900	0.06	NA	Yes
1,1,2-Trichloroethane	8.1	0.20	5	Yes
Trichloroethylene	26,000	0.03	5	Yes
Vinyl chloride	350	0.02	2	Yes
cis-1,2-Dichloroethene	1,500	61	70	Yes
Other				
Perchlorate	76	24.5	NA	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. For perchlorate, the EPA Drinking Water Equivalency Level was used. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
[5]Metals may represent high turbidity in the sample and, therefore, not be representative of groundwater contamination.
NA – Not applicable.
µg/L – micrograms per liter.

Table 7. Contaminants Detected in RSA-149 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Pesticides				
Dieldrin	0.1	0.004	NA	Yes
SVOCs				
bis (2-Chloroethyl) ether	43	0.1	NA	Yes
bis (2-Ethylhexyl)phthalate	140	4.8	6	Yes
Hexachloroethane	10	4.8	NA	Yes
VOCs				
Acetone	28,000	5,475	NA	Yes
Benzene	370	0.35	5	Yes
Bromodichloromethane	5.1	0.18	80	No
Carbon tetrachloride	58,000	0.17	5	Yes
Chloroform	1,500	0.17	80	Yes
Methylene chloride	6,000	4.3	5	Yes
1,1,2,2-Tetrachloroethane	770	0.06	NA	Yes
Tetrachloroethene	340	0.10	5	Yes
Trichloroethylene	120,000	0.03	5	Yes
Vinyl chloride	3.7	0.02	2	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
NA – Not applicable.
µg/L – micrograms per liter.

Table 8. Contaminants Detected in RSA-150 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Explosives				
RDX	1.4	0.61	NA	Yes
SVOCs				
Benzo(k)fluoranthene	1.2	0.92	NA	Yes
bis(2-Ethylhexyl)phthalate	44	4.8	6	Yes

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
VOCs				
Benzene	5.6	0.35	5	Yes
Carbon tetrachloride	13	0.17	5	Yes
Trichloroethylene	63	0.03	5	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
NA – Not applicable.
µg/L – micrograms per liter.

Table 9. Contaminants Detected in RSA-151 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Explosives				
2-Nitrotoluene	0.55	0.05	NA	Yes
RDX	96	0.61	NA	Yes
SVOCs				
Bis (2-Ethylhexyl)phthalate	540	4.8	6	Yes
VOCs				
Acetone	6,600	5,475	NA	Yes
Benzene	400	0.35	5	Yes
Bromodichloromethane	3.9	0.18	80	No
Bromomethane	1,900	8.7	NA	Yes
Carbon tetrachloride	34	0.17	5	Yes
Chloroform	620	0.17	80	Yes
Chloromethane	9.4	158	NA	No
Methylene chloride	8,500	4.3	5	Yes
1,1-Dichloroethane	1,700	811	NA	Yes
1,1-Dichloroethene	2,200	339	7	Yes
1,2-Dichloroethane	79	0.12	5	Yes
Cis-1,2-Dichloroethene	8,500	61	70	Yes
1,1,2,2-Tetrachloroethane	1,900	0.06	NA	Yes
Tetrachloroethene	3,700	0.10	5	Yes
1,1,1-Trichloroethane	6,000	3,172	200	Yes
1,1,2-Trichloroethane	56	0.20	5	Yes
Trichloroethylene	100,000	0.03	5	Yes
Vinyl chloride	4,700	0.02	2	Yes

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Other				
Perchlorate	106,000	24.5	NA	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. For perchlorate, the EPA Drinking Water Equivalency Level was used. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
NA – Not applicable.
µg/L – micrograms per liter.

Table 10. Contaminants Detected in RSA-152 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Explosives				
2-Nitrotoluene	0.15	0.05	NA	Yes
Nitroglycerin	86	4.8	NA	Yes
RDX	1.2	0.61	NA	Yes
SVOCs				
4-Nitroaniline	19	3.2	NA	Yes
VOCs				
Carbon tetrachloride	6,000	0.17	5	Yes
Chloroform	140	0.17	80	Yes
1,2-Dichloroethane	19,000	0.12	5	Yes
1,2-Dichloroethene	1,100	NA	NA	No
Methylene chloride	290	4.3	5	Yes
Tetrachloroethene	420	0.10	5	Yes
1,1,2,2-Tetrachloroethane	1,700	0.06	NA	Yes
Trichloroethylene	13,000	0.03	5	Yes
1,1,2-Trichloroethane	61	0.20	5	Yes
Vinyl chloride	96	0.02	2	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
NA – Not applicable.
µg/L – micrograms per liter.

Table 11. Contaminants Detected in RSA-153 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Metals[5]				
Lead	20	15	15	Yes
SVOCs				
bis (2-Chloroethyl)ether	4.8	0.01	NA	Yes
bis (2-Ethylhexyl)phthalate	6.5	4.8	6	Yes
VOCs				
Bromodichloromethane	12	0.18	80	No
Carbon tetrachloride	11	0.17	5	Yes
Trichloroethylene	17	0.03	5	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
[5]Metals may represent high turbidity in the sample and, therefore, not be representative of groundwater contamination.
NA – Not applicable.
µg/L – micrograms per liter.

Table 12. Contaminants Detected in RSA-154 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG/MCL Exceeded?[4]
Explosives				
Nitroglycerin	150	4.8	NA	Yes
2-Nitrotoluene	1.4	0.05	NA	Yes
RDX	1.7	0.61	NA	Yes
SVOCs				
Benzo(a)anthracene	1.3	0.09	0.09	Yes
Benzo(b)fluoranthene	0.94	0.09	0.09	Yes
Benzo(k)fluoranthene	1.2	0.92	0.92	Yes
2-Methylnaphthalene	230	NA	NA	No
Naphthalene	76	6.2	6.2	Yes
VOCs				
Benzene	10	0.35	5	Yes
Carbon tetrachloride	55	0.17	5	Yes
1,1-Dichloroethene	34	339	7	Yes
Tetrachloroethene	20	0.10	5	Yes
1,1,2-Trichloroethane	17	0.20	5	Yes
Trichloroethylene	66,000	0.03	5	Yes
Other				
Perchlorate	32	24.5	NA	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. For perchlorate, the EPA Drinking Water Equivalency Level was used. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
NA – Not applicable.
µg/L – micrograms per liter.

Table 13. Contaminants Detected in RSA-155 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
SVOCs				
Naphthalene	6.8	6.2	NA	Yes
VOCs				
Benzene	1400	0.35	5	Yes
Carbon tetrachloride	810	0.17	5	Yes
Chloroform	350	0.17	80	Yes
Tetrachloroethylene	11	0.10	5	Yes
Trichloroethene	110	0.03	5	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
NA – Not applicable.
µg/L – micrograms per liter.

Table 14. Contaminants Detected in RSA-156 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Explosives				
RDX	0.78	0.61	NA	No
VOCs				
1,2-Dichloroethene	2.4	NA	NA	No
Trichloroethylene	25	0.03	5	Yes
Vinyl Chloride	2.3	0.02	2	Yes
Other				
Perchlorate	52.3	24.5	NA	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. For perchlorate, the EPA Drinking Water Equivalency Level was used. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
NA – Not applicable.
µg/L – micrograms per liter.

Table 15. Contaminants Detected in RSA-157 Groundwater Site above PRGs or MCLs

Contaminant[1]	Maximum Detected Groundwater Concentration (µg/L)	PRG[2] (µg/L)	MCL[3] (µg/L)	PRG or MCL Exceeded?[4]
Metals[5]				
Mercury	2.7	10.95	2	Yes
Explosives				
2-Nitrotoluene	0.24	0.05	NA	Yes
RDX	0.63	0.61	NA	Yes
VOCs				
Trichloroethylene	190	0.02	5	Yes

[1]All chemical acronyms can be found in the Acronym List.
[2]PRG – EPA, 2004, Region 9 Preliminary Remediation Goal Table, San Francisco, California, October. Toxicity values for some chemicals have been updated by the Integrated Risk Information System since the publication of the EPA (2004) Region 9 PRGs. The updated values are used to recalculate the PRG for a given chemical using Region 9 methodology, and the revised PRG is used as the basis for developing the risk-based screening concentration.
[3]MCL – Maximum Contaminant Level from EPA, 2006, 2006 Edition of the Drinking Water Standards and Health Advisories, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.
[4]Yes, if the concentration exceeded the MCL, or the PRG if an MCL does not exist. No, if the concentration is less than the MCL, or less than the PRG if an MCL does not exist.
[5]Metals may represent high turbidity in the sample and, therefore, not be representative of groundwater contamination.
NA – Not applicable.
µg/L – micrograms per liter.

This screening evaluation of risk demonstrates that chemicals of potential concern (COPC) are present at all groundwater sites on Redstone Arsenal. For most sites, groundwater may pose carcinogenic risks or result in adverse noncarcinogenic health effects to human receptors if the groundwater were used for potable purposes. The contaminated groundwater under the Arsenal is considered by ADEM to be potentially usable, but it is not currently used as potable drinking water (see Section 2.6.2). Uncontrolled current or future use of this groundwater for potable or nonpotable purposes may pose potentially unacceptable risks to human receptors who may contact and ingest this medium. The comparison of groundwater concentrations to PRGs or MCLs, as shown in Tables 3 through 15, demonstrates that Redstone Arsenal groundwater concentrations exceed, and sometimes greatly exceed, these health-based criteria or promulgated standards. The results of this comparison support the need for implementing an IRA until final remedies are selected for the groundwater sites. Groundwater sites will undergo a comprehensive quantitative human health risk assessment in the RI efforts associated with each site.

Throughout the Arsenal, groundwater occurs at depths ranging from a few feet below the surface (in low-lying areas) to up to 30 to 35 feet below the surface. Since the groundwater at depth is currently not used as a potable water source, there are only limited potential human health exposures, and ecological receptors are not exposed to subsurface groundwater. However,

groundwater does discharge to surface water at numerous springs and seeps which present both human health and ecological exposure points. An evaluation of risks posed by groundwater to ecological receptors is not part of the scope of this IRA (see Section 2.4.2). However, the Army is currently conducting an evaluation of the Integrator OUs which will address the potential risks resulting from contaminated groundwater contributing to surface water and wetland systems. Integrator OUs are defined as surface water bodies (e.g., site streams and the Tennessee River), wetlands, and floodplains where contamination from releases that have occurred at multiple surface media and/or groundwater sites have become commingled. The Integrator OU approach has been established at Redstone Arsenal to evaluate surface water and wetland systems where multiple sources of contamination may be contributing to a single area. The Integrator OU term is used because these topographically low-lying geographic features have become the integrator of multiple sources of contamination.

This risk evaluation reveals that groundwater users potentially exposed to COPCs via the ingestion exposure pathway may have unacceptable human health exposure. Thus, if the IRA is not implemented, there may be substantial endangerment to public health and welfare. This action is limited to an IRA for IWGW.

2.8 Interim Remedial Action Objectives

Results of the groundwater sampling through various investigations conducted across the Arsenal supports the need to control groundwater use or exposure at Redstone Arsenal. The IRAOs have been identified for the IWGW at Redstone Arsenal based on potential exposure pathways. The IRAOs have been developed and describe what the proposed IRA is expected to accomplish. These objectives serve as the design basis for the IRA alternatives presented in Section 2.9. The following IRAOs were developed to protect human receptors from consumption of contaminated groundwater or from other unmanaged exposure to groundwater at Redstone Arsenal:

- Prevent current and future human receptors from using groundwater for potable uses on the Arsenal. This includes, but is not limited to, restrictions on installing drinking water wells, extracting groundwater from current and future monitoring wells for potable use (e.g., drinking, cooking), and drinking water from seeps and springs.

- Manage nonpotable groundwater uses within Arsenal boundaries such that uncontrolled human exposure to contaminated groundwater is prevented, including but not limited to, construction- and remediation-based activities, irrigation, and maintenance activities.

- Develop a formal coordination process with adjacent government entities to enable the Army to provide information and assistance during governmental review of applications for well installation or other construction activities where groundwater may be encountered. The intent of the coordination would be to prevent or minimize potential exposure of off-post residents or workers to contaminated groundwater in addition to preventing further migration of the Redstone Arsenal plume off of the Arsenal.

These IRAOs provide exposure control for on-post and off-post workers and residents currently and in the future. The purpose of this IRA is to prevent, control, or manage ingestion of groundwater so that the risks to human health are eliminated or minimized until final remedies for groundwater are in place. No preliminary cleanup goals are warranted as part of this IRA, because the scope is to provide controls for groundwater use and eliminate or minimize exposure. The action does not involve active contaminant remediation or contaminant plume containment. The IRA will not result in contaminant or risk reduction but provides current and future protection for human health through administrative and legal controls.

2.9 Description of Remedial Alternatives

The Army considered two IRA alternatives to achieve the IRAOs for the IWGW at Redstone Arsenal. These two alternatives included 1) No Action; and 2) LUCs. This section contains a narrative summary of the two alternatives that were considered for the IRA.

2.9.1 Alternative 1 – No Action

The NCP requires consideration of a No Action alternative against which other alternatives can be compared. The No Action alternative assumes that the Army will not implement any formal action outside of the current SAC program to control groundwater use on the Arsenal and will continue to conduct informal reviews with local government agencies over groundwater use for drinking and non-drinking water (i.e., well permit reviews). This alternative is typically not selected unless the risks of doing nothing are acceptable to human health.

2.9.1.1 Description of Remedy Components

Treatment Components. Alternative 1, No Action, does not include a treatment component for the groundwater.

Containment Components. Alternative 1, No Action, does not include containment (i.e., engineering controls) for groundwater.

Land-Use Controls. Alternative 1, No Action, does not include LUCs for the groundwater.

Operation and Maintenance. Alternative 1, No Action, requires no additional O&M to maintain the integrity of the remedy.

Monitoring Requirements. Alternative 1, No Action, does not include monitoring requirements for groundwater.

2.9.1.2 Common Elements and Distinguishing Features

Applicable or Relevant and Appropriate Requirements. ARARs will not be fully satisfied by Alternative 1, No Action. Compliance with ARARs or requesting a waiver from EPA will be required for the final action for the groundwater sites, however.

Long-Term Reliability/Effectiveness. Alternative 1, No Action, is not reliable or effective in the long-term.

Waste. Alternative 1, No Action, does not generate waste to be managed.

Cost, Construction Times, and Time to Achieve Interim Remedial Action Objectives. Alternative 1, No Action, has no additional costs beyond what is already spent to implement the Arsenal's SAC program. The SAC program is already being implemented but does not fully meet the IRAOs from Section 2.8.

- Estimated Capital Cost: $0
- Estimated Annual O&M Cost: $0
- Estimated Present Worth Cost: $0
- Estimated Construction Time Frame: None

2.9.1.3 Expected Outcomes

Land Use. Alternative 1, No Action, would not prohibit or limit any land use at the Arsenal currently or in the future. Restrictions would be in place to prohibit installation of drinking water wells on the Arsenal through the SAC program. However, no additional Army controls would be invoked for potential exposure to groundwater off the Arsenal (e.g., no fencing/signage at potentially contaminated seeps and springs, and no formalized coordination would be in place to prevent installation of wells off the Arsenal).

Other Impacts or Benefits. Alternative 1, No Action, would potentially expose human receptors to contaminated groundwater, because the current controls do not apply off the Arsenal or to contaminated seeps/springs on the Arsenal where workers or visitors could encounter them.

2.9.2 Alternative 2 – Land-Use Controls

The LUCs that have been selected involve legal and administrative actions by the Army to control groundwater use under the Arsenal and to coordinate with the local government entities so that informed decisions can be made by these entities for off-post groundwater use impacted by Redstone Arsenal. Within 90 days of IROD signature, the Army shall prepare and submit to EPA and ADEM for review and approval an LUC RD that shall contain land use implementation and maintenance actions. The following LUC objectives have been established to meet the IRAOs in Section 2.8.

- Prohibit the use of groundwater (including seeps and springs) at Redstone Arsenal for drinking water purposes or for other potable water uses.

- Prevent human exposure to contaminated groundwater from nonpotable uses without prior Army approval.

- Although the following objective will not be associated with an LUC, as an interim measure the Army intends to develop a formal coordination process (such as memoranda of agreement) with bordering government entities which are responsible for reviewing applications or permits for activities off the Arsenal, such as installation of groundwater wells, where potentially contaminated groundwater may be encountered and where the Army is not in control of the action. The governments that border Redstone Arsenal are Madison County, the cities of Madison and Huntsville, and Morgan County. The town of Triana is located approximately one-half mile from the western boundary of Redstone Arsenal and will be included in formal coordination activities as well. Achieving this objective will allow consistent Army review of and input into planned well installation or construction activities where exposure to contaminated groundwater could result or where the actions could result in further off-post migration of the Redstone Arsenal plumes.

Currently, the SAC program administered by the Army prohibits the installation of wells for water uses including consumption, industrial processes, and agricultural purposes. In addition, the SAC program contains a number of provisions which ensure that human protection from nonpotable uses of groundwater is provided. For example, requests for proposed activities that may encounter or withdraw groundwater for nonpotable uses, including but not limited to, new construction and remediation-based projects, irrigation, and maintenance activities are reviewed and approved in accordance with Redstone Arsenal Regulation 200-7. Requests are submitted through the Directorate of Public Works which coordinates with a designated IRP point of

contact to determine if the requested work involves an IRP site. Based on this review, project specific controls, such as the need for site-specific health and safety plans, may be required and the requestor is then responsible for implementing these controls before starting work.

The LUC RD document will be prepared to specify the details of the groundwater LUCs and how they will be implemented, maintained, and reported. This LUC RD will be a legally enforceable document. It is anticipated that the administrative procedures to be included in the LUC RD for prohibiting use of groundwater for potable purposes on the Arsenal and for managing groundwater use for nonpotable purposes will be similar to those specified in the current SAC program administered by the Army, as shown in Bullets 1 and 4 of Section 2.2.2 and as discussed above. The scope of these procedures will identify activities on the Arsenal that would involve potential contact with contaminated groundwater and will develop mechanisms to implement the groundwater LUC objectives. The LUC RD will specify that review and approval will be required from a designated Army reviewer for work activities, where exposure to contaminated groundwater for nonpotable uses may occur, before work can proceed. The designated Army reviewer and the mechanism to implement reviews will be identified in the LUC RD document. This alternative is intended to protect human health from exposure to contaminated groundwater (including seeps and springs) until final groundwater remedies are selected.

State laws and regulations or city ordinances for government entities adjacent to Redstone Arsenal have provisions requiring that drilling applications or permits be filed with either city, county, or state government entities before water wells are drilled. Applications or permits are also required for many other activities where groundwater might be encountered or become available for people to contact, such as the construction of a pond or installation of a swimming pool. Table 16 presents a summary of the state regulations and city ordinances currently in place which require that drilling applications or permits be obtained prior to any well drilling. Formal Army coordination through administrative mechanisms, such as memoranda of agreement, with these adjoining government agencies as well as other government entities on the Arsenal, including the U.S. Fish and Wildlife Service-Wheeler National Wildlife Refuge and the Tennessee Valley Authority, will be developed as part of the administrative controls to ensure that installation of new drinking and non-drinking water wells is protective of the community and that off-post groundwater contamination originating from Redstone Arsenal is considered during other permitted construction activities as well. The Army has historically interfaced with these government entities on an informal basis over groundwater contamination issues including reviews of well permits. Arsenal staff has met with local officials, contractors, and developers;

participated in town meetings; and provided resource materials such as contaminant plume maps to assist in preventing inadvertent contact with contaminated groundwater.

Since groundwater contamination will not allow unrestricted use during this IRA, CERCLA five-year reviews will be required.

2.9.2.1 Description of Remedy Components

Treatment Components. Alternative 2, LUCs, does not include a treatment component for the groundwater as part of the IRA.

Containment Components. Alternative 2, LUCs, does not include containment (engineering controls) for groundwater.

Table 16. Enforcement Authority for Water Well Installation and Water Well Quality for Local Government Entities

Governmental Organization	Ordinance, Regulation or Law	Provision of Ordinance, Regulation or Law	Permit or Application Process Description
City of Huntsville	City of Huntsville Code Chapter 12, Article VII, Division 2, Section 12-432	A permit must be submitted before drilling any well within city limits.	Permits are submitted to the City for review of well installation. Other activities such as installation of pools or ponds are reviewed as well.
City of Madison	Madison City Code Section 13-170	The city uses the Madison County application but provides approval.	The process is initiated by submitting the Madison County permit. The city will review and provide approval based on the County Health Department's review and approval.
Town of Triana	See Madison County	See Madison County	Any request for a well is managed through Madison County.
Madison County	Legal basis provided under State laws governing well installations and public health laws. See laws and regulations listed under the State of Alabama.	An application is required.	Madison County has a permitting process for all well installations. This process is administered through the County Health Department. The Health Department performs site visits and approvals.
Morgan County	Legal basis provided under State laws governing well installations and public health laws.	Morgan County does not have a permitting or approval process for well installation. Refer to the State requirements.	Review function is performed by the State though health provisions are administered through the County Health Department.

Governmental Organization	Ordinance, Regulation or Law	Provision of Ordinance, Regulation or Law	Permit or Application Process Description
State of Alabama- ADEM	Installation of Water Wells- State Law (SL) 22-24 Regulations provided in Code of Alabama Regulations (CAR) 335-9	Wells must be installed by a licensed driller (SL 22-24-8(1)) -Notification of Intent to drill and Certification of Completion must be filed with the state (SL 22-24-8(3)) -State is required to notify the local health authorities after completion (SL 22-24-8(4)) -There are stipulated penalties for not complying -State has the authority to enforce this law (SL 22-24-3) -Regulations for well drilling and construction are provided in CAR 335-9	An Intent to Drill form and a Certification of Completion form must be submitted to ADEM and if requested to the Alabama Geological Survey.
State of Alabama- State Board of Health	Control of Well Water Quality— See Title 22	The State Board of Health and, as delegated to the County Boards of Health (or district if 2 or more counties join in a district), have the authority to inspect and abate "sources of supply and conveyances of drinking water."	Review, inspection, and enforcement are enacted at the local level by the County Health Department. In accordance with State law, enforcement of health standards can only occur by the State or County boards of health and their staff. Municipalities may not hire municipal health officers (SL 22-1-3)

CAR – Code of Alabama Regulation
SL – State Law

Land-Use Controls. Alternative 2, LUCs, includes legal and administrative controls to prevent groundwater use as a potable water source and to manage any nonpotable water use on the Arsenal. The Army will prepare and submit the LUC RD document that contains the implementation and maintenance actions, including periodic inspections, to EPA and ADEM with the following conditions:

- LUC Duration - the LUCs in this IROD will be implemented and maintained until such time as the final groundwater RODs supersede this IROD. Any LUCs in this IROD deemed necessary in the final groundwater remedies will be carried forward to the groundwater site RODs and maintained until the concentrations of hazardous substances in the groundwater are at such levels to allow for unrestricted use and exposure.

- Changes or Termination of LUCs - the Army shall not modify, delete, or terminate any LUC without the concurrence of EPA and ADEM.

- LUC Maintenance and Reporting - the Army is responsible for implementing, maintaining, reporting on, and enforcing the LUCs described in this IROD in accordance with the LUC RD document.

Operation and Maintenance. Alternative 2, LUCs, will include O&M to implement, inspect, and report the LUCs and coordinate formal agreements with adjacent government agencies. Five-year CERCLA reviews will also be conducted.

Monitoring Requirements. Alternative 2, LUCs, does not include any groundwater monitoring requirements since groundwater sampling and analysis will be a component of the groundwater site RIs.

2.9.2.2 Common Elements and Distinguishing Features

ARARs. This interim action in combination with the final actions at the groundwater sites will achieve compliance with ARARs (MCLs), or a waiver will be requested.

Long-Term Reliability/Effectiveness. Alternative 2, LUCs, are reliable and effective for the long term in controlling human exposure to contaminated groundwater.

Waste. Alternative 2, LUCs, does not generate waste to be managed.

Cost, Construction Times, and Time to Achieve Interim Remedial Action Objectives. Below are the estimated cost data for implementation of the LUCs as well as the implementation time frame.

Total Capital Cost:	$246,856
Total Annual O&M Cost:	$90,000
Total Intermittent O&M Cost:	$102,064
Total Present Worth Cost:	$775,000
Estimated Construction Time Frame:	1 month
Estimated Time to Achieve RAOs:	12 months for implementation of the RD document

2.9.2.3 Expected Outcomes

Land Use. Alternative 2, LUCs, would not prohibit any soil land use at the Arsenal. Continued building may occur through the Base Master Plan organization (Army, 2006b). Restrictions would be in place to prohibit installation of drinking water wells on the Arsenal through an enhanced SAC program component. Formal coordination agreements with local

government entities would be put in place to ensure coordination with activities off post that may affect groundwater use, such as installation of wells (drinking and non-drinking water) or other construction projects that could expose the community to contaminated groundwater.

Other Impacts or Benefits. This alternative would minimize the potential exposure pathways for human receptors to contaminated groundwater, both on and off the Arsenal.

2.10 Comparative Analysis of Alternatives

The two alternatives have been evaluated against the nine CERCLA criteria, which provide the basis for evaluating the alternatives and selecting a remedy. CERCLA requires that the nine criteria be used to evaluate remedial alternatives individually and against each other in order to select a remedy. The comparison is presented in this section and in Table 17.

Table 17. Evaluation of Alternatives against Threshold and Primary Balancing Criteria

Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction in Toxicity, Mobility, or Volume through Treatment	Short-Term Effective-ness	Implement-ability	Cost (Total Present Worth)
No Action - Alternative 1	Not fully protective of human health. Protection of the environment is not satisfied by this action.	Does not achieve compliance with ARARs.	Effective but less so than Alternative 2. Long-term permanence not required to be satisfied by this action.	Not required to be satisfied by this action.	Not effective	Readily Implement-able	$0
Land-Use Controls - Alternative 2	Protective of human health. Protection of the environment is not satisfied by this interim action.	This alternative will meet all ARARs specifically associated with this limited scope. This interim action in combination with the final actions at the groundwater sites will achieve compliance with ARARs or a waiver will be requested.	Effective for the long term but permanence not required to be satisfied by this interim action.	Not required to be satisfied by this interim action.	Effective	Implement-able	$775,000

1. ***Overall Protection of Human Health and the Environment.*** Alternative 1 (No Action) is not fully protective of human health because actions would not be taken as part of the current SAC program to ensure that off-site groundwater use is reviewed and managed for public protection outside of the current informal arrangement. Alternative 2 is protective of human health because additional

controls will be in place to ensure groundwater use is controlled or managed. Neither alternative is expected to have any net positive effect on the environment.

2. ***Compliance with ARARs.*** Alternative 1 does not achieve compliance with ARARs at this time. Alternative 2, LUCs, will meet all ARARs specifically associated with this limited scope and, in combination with the final actions at the groundwater sites, will achieve compliance with all ARARs, or a waiver will be requested in accordance with NCP Section 300.430(f)(1)(ii)(C).

3. ***Long-Term Effectiveness and Permanence.*** Neither alternative will meet long-term permanence because nothing is performed to reduce toxicity, mobility, or volume of the contaminants through treatment to the maximum extent practicable. However, permanence is not required to be satisfied by this IRA. The LUCs in Alternative 2 provide long-term effectiveness and are likely to be a component in the final remedies for the groundwater sites. The No Action alternative is effective but not to the same degree as Alternative 2 for the long term.

4. ***Reduction of Toxicity, Mobility, or Volume through Treatment.*** Neither Alternative 1 nor Alternative 2 reduces the toxicity, mobility, or volume of contaminants through treatment other than natural attenuation degradation mechanisms. None of the groundwater sites are far enough along in the site characterization process to be at a point where treatment can be implemented. This balancing criterion will be considered in the final remedies for groundwater sites once characterization is complete.

5. ***Short-Term Effectiveness.*** Alternative 1 does not ensure formal and consistent review of potential off-post well installation. Alternative 1 is, therefore, not effective. The implementation of Alternative 2 presents no short-term threats to workers since no active remediation is employed. The implementation of administrative controls (such as memoranda of agreement) with adjacent government entities to ensure that groundwater use is reviewed for public safety would be effective and implemented quickly. Therefore, Alternative 2 would be effective in the short-term.

6. ***Implementability.*** There are no technical or administrative difficulties associated with the implementation of Alternative 1 because no additional action would be taken outside of the SAC program already in place. Thus, Alternative 1 is readily implementable. The LUCs in Alternative 2, which involve routine inspections, periodic monitoring and reporting, and administrative procedures, can be implemented without difficulty. It is anticipated the LUC RD document prepared for Alternative 2 will be readily approved by EPA and ADEM for implementation by the Army.

7. ***Cost.*** The present value for Alternative 1 is $0. The total present worth cost for Alternative 2 is $775,000. These costs are beyond what the Army incurs presently for the SAC program currently in place. Table 18 presents the detailed costs for Alternative 2.

Table 18

Cost Estimate for the Selected Remedy
Redstone Arsenal, Madison County, Alabama

Capital Cost

	Description	Quantity	Unit	Unit Cost	Cost
1	Prepare Land Use Control				
	Remedial Design (LUC RD)[1]		LS	$55,000	$55,000
	Modify SAC Program[1]		LS	$10,000	$10,000
2	Modify SAC Program Construction Tracking Database[1]		LS	$15,000	$15,000
3	Negotiate MOA w/ Governmental Authorities[1]	4	Each	$15,000	$60,000
4	LUC for Contaminated Seeps and Springs				
	Prepare Inventory of Seeps/Springs[1]		LS	$10,000	$10,000
	Construct Warning Signs[2,3]	37	Each	$182	$6,734
Subtotal					$156,734
Contingency Allowance (50%)[5]					$78,367
Project Management & Support (7.5%)					$11,755
Total Capital Cost					$246,856

Annual Operation and Maintenance (O&M) Cost

Annual O&M Costs[6]					
1	SAC Program inspections/reporting[1]		LS	$20,000	$20,000
2	Maintain construction tracking database[1]		LS	$20,000	$20,000
3	MOA coordination		LS	$50,000	$50,000
Subtotal of Annual O&M Costs					$90,000
Intermittent O&M Costs[8]					
4	Informational meetings[7] (every 5 years)	1	Each	$35,000	$35,000
5	Public awareness fact sheets (every 5 years)	4	Each	$10,000	$40,000
6	Replace Warning Signs (every 10 years)	37	Each	$182	$6,734
7	CERCLA Site Review (every 5 years)[9,11]	1	Site	$20,330	$20,330

Summary of Present Worth Analysis[12]

Year	Capital Cost	Annual O&M Cost	Total Cost	Discount Factor[10]	Present Worth
0	$246,856	$0	$246,856	1.000	$246,856
1		$90,000	$90,000	0.970	$87,294
2		$90,000	$90,000	0.941	$84,669
3		$90,000	$90,000	0.912	$82,123
4		$90,000	$90,000	0.885	$79,654
5		$225,990	$225,990	0.858	$193,997
6		$0	$0	0.833	$0
7		$0	$0	0.808	$0
8		$0	$0	0.783	$0
9		$0	$0	0.760	$0
10		$0	$0	0.737	$0
11		$0	$0	0.715	$0
12		$0	$0	0.693	$0
13		$0	$0	0.672	$0
14		$0	$0	0.652	$0
15		$0	$0	0.633	$0
16		$0	$0	0.614	$0
17		$0	$0	0.595	$0
18		$0	$0	0.577	$0
19		$0	$0	0.560	$0

Table 18

Cost Estimate for the Selected Remedy
Redstone Arsenal, Madison County, Alabama

20		$0	$0	0.543	$0
21		$0	$0	0.527	$0
22		$0	$0	0.511	$0
23		$0	$0	0.496	$0
24		$0	$0	0.481	$0
25		$0	$0	0.466	$0
26		$0	$0	0.452	$0
27		$0	$0	0.439	$0
28		$0	$0	0.425	$0
29		$0	$0	0.413	$0
30		$0	$0	0.400	$0
Total	$246,856	$585,990	$832,846		$774,594

Total Present Worth Cost **$775,000**

Notes:
LUC RD = Land Use Control Remedial Design
SAC = Site Access Control
LS = Lump Sum
MOA = Memorandum of Agreement
[1] Estimated using best professional judgement
[2] Estimated from RS Means Site Construction Cost Data, 2006
[3] Assumptions for warning sign estimate:
Number of contaminated seeps and spings = 37
Number of signs at each seep/spring = 1 Useful life (years) = 10
[5] Contingency is elevated because of uncertainty in best professional judgement estimates.
[6] O&M costs that are incurred every year.
[7] Estimate based on actual cost of holding a public meeting.
[8] O&M costs that are not incurred every year. Cost estimates from 2006 RS Means unless otherwise indicated.
[9] Unit cost of site review from RACER.
[10] Discount Factor = $1/(1+i)^t$, i = discount rate and t = year. Discount Rate = 0.031
[11] Schedule of ROD signatures for IWGW sites:

Year	Sites
2010	2
2011	5
2012	3
2013	3
Total	13

[12]Present worth is the amount of money that would need to be invested at the discount rate (i) at the beginning of the project (Year 0) to have adequate funds to meet project expenditures in the future (USACE and EPA, 2000).

8. ***State Support/Agency Acceptance.*** EPA and ADEM are in agreement with Alternative 2, the Selected Remedy.

9. ***Community Acceptance.*** The community did not express objections or concerns during the public comment period on the PP for IWGW.

2.11 Selected Remedy

The selected IRA is Alternative 2, LUCs. This IRA will protect human health by ensuring that exposure to groundwater is controlled or managed until the final remedies for groundwater sites are in place.

2.11.1 Detailed Description of the Selected Remedy

Based upon the characterization data, a qualitative evaluation of risk, IRAOs, and the evaluation of alternatives, the selected IRA for IWGW is LUCs including the development of formalized coordination procedures between the Army and bordering government entities regarding permitted activities which could result in groundwater exposure (e.g., water well installation). These LUCs are administrative and legal controls to ensure that groundwater consumption is prevented on the Arsenal and that nonpotable groundwater use is managed. The boundary of the LUCs is the Arsenal boundary, with the exception of the central area occupied by NASA (see Figures 2 and 3). NASA is preparing a separate IRA PP and IROD for groundwater under the MSFC. This Army IWGW IRA is not the final action for groundwater, although it is effective in the long and short terms for controlling potential human exposure to groundwater. It is likely that LUCs will also be selected as a component of the final remedies at the groundwater sites to maintain viability, effectiveness, and protectiveness of the final selected remedies for these sites.

Implementation of the selected IRA will ensure control over uses of potable and nonpotable water sources on the Arsenal and will allow the Army to have input into decisions on the uses of groundwater in surrounding areas off the Arsenal. Within 90 days of IROD signature, the Army will prepare and submit to EPA and ADEM for review and approval an LUC RD document that will contain implementation and maintenance actions, including periodic inspections.

Implementation of the selected IRA will achieve the IRAOs discussed in Section 2.8 to protect the public from exposure to groundwater. The LUCs will provide adequate assurances that no one on the Arsenal will drink the groundwater and that the groundwater will be managed for nonpotable water uses to ensure safety. The selected IRA provides protection rather than contaminant or risk reduction. Once the groundwater is remediated within each groundwater site, reduction in risk from the groundwater and soil vapors can be expected.

2.11.2 Cost Estimate for the Selected Remedy

The costs associated with the selected IRA are detailed in Table 18. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost. The information in this cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an explanation of significant difference, or a ROD amendment.

2.11.3 Expected Outcomes of the Selected Remedy

The selected IRA provides several key benefits over the other alternative (No Action). These benefits include:

- The selected IRA provides protection to human receptors who could encounter contaminated groundwater before it is cleaned up, both on and off the Arsenal. The current SAC program does not protect against potential groundwater consumption off the Arsenal and the selected IRA includes a remedy component that will develop a formal coordination process for the Army to provide information and assistance during review of off-Arsenal well installation and other permitted construction operations where groundwater may be encountered.

- The selected IRA allows continued construction and maintenance activities consistent with the Army's mission, including BRAC, in accordance with the Base Master Plan (Army, 2006b). It also ensures protection in the future if portions of the Arsenal are ever excised or leased.

- The selected IRA provides short-term effectiveness and is easily and quickly implemented. The remedy will remain in effect until such time as the final groundwater RODs are completed. As each groundwater ROD is completed, any LUCs in those RODs will supersede those in this IROD, providing a smooth transition from interim to final action.

- This IRA does not preclude the Army from taking other interim actions that might be appropriate before the final remedies are in place for groundwater.

- The surface media RODs can be completed, allowing remediation and site closure because ADEM has achieved its goal of enforcement control over groundwater until final actions are in place. Remediation of the surface media sites also provides protection of groundwater from further transport of contaminants in soil.

- Although this IRA does not specifically have groundwater monitoring as part of its scope, long-term groundwater monitoring will be conducted at the various groundwater sites and elsewhere on the Arsenal. The information will be periodically reported to the public in public meetings and fact sheets.

The selected IRA must be consistent with the final remedy for the groundwater sites and must not negatively impact the overall problem. The Army and EPA Region 4 have selected Alternative 2 as the Selected Remedy, and ADEM concurs.

2.12 Statutory Determinations

Based on the data collected to date for the IWGW, the groundwater presents risk to human receptors who could encounter contaminated groundwater before it is cleaned up, both on and off the Arsenal. Therefore, Alternative 2 has been identified as the selected IRA for IWGW.

The selected IRA is consistent with CERCLA and, to the extent practicable, the NCP and is protective of human health for the interim until permanent remedies are put in place. This action will meet all ARARs specifically associated with this limited action. The final action at the groundwater sites in combination with this interim action will either achieve compliance with ARARs or will provide grounds for invoking a waiver under §300.430(f)(1)(ii)(C) of the NCP. The remedy is cost effective, as discussed in Section 2.12.3. This IRA will not result in reduction in toxicity, mobility, or volume of contamination through treatment and will not utilize permanent solutions to the maximum extent possible. However, the selected IRA provides the best balance of trade-offs among the alternatives. Because of the interim nature of this action, five-year CERCLA reviews of the selected IRA will be required.

2.12.1 Selected Remedy is Protective of Human Health

The interim remedy for IWGW at this site will adequately protect human health by controlling exposure to all human receptors through LUCs. The selected IRA implements the necessary administrative actions to ensure that groundwater is not used for potable water purposes and managed for nonpotable water use for the protection of human health. The remedy is an interim action and will be superseded by final remedies for the individual groundwater sites.

2.12.2 Selected Remedy Complies with ARARs

This IRA will meet all ARARs specifically associated with this limited scope and, in consideration with the final actions at the groundwater sites, will achieve compliance with all ARARs, or a waiver will be requested in accordance with NCP Section 300.430(f)(1)(ii)(c).

2.12.3 Selected Remedy is Cost Effective

In the lead agency's judgment, the Selected Remedy is cost effective because the remedy's costs are proportional to its overall effectiveness (see 40 Code of Federal Regulations 300.430[f][1][ii][D]). This determination was made by evaluating the overall effectiveness of

those alternatives that satisfied the threshold criteria. Overall effectiveness was evaluated by assessing three of the five balancing criteria (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness) in combination. The overall effectiveness was then compared to the alternative's costs to determine cost effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence represents a reasonable value for the money to be spent.

2.12.4 Five-Year Reviews for the Selected Remedy

Because the remedy will result in groundwater contaminant levels that will restrict use and exposure, a review will be conducted within five years after initiation of the IRA to ensure that the remedy continues to provide protection of human health. Reviews will continue every five years until the groundwater remedies are in place.

2.13 Documentation of Significant Changes

No significant change has been made to the Preferred Alternative presented in the PP for the IWGW IRA (Shaw, 2007).

3.0 Responsiveness Summary

The Responsiveness Summary serves three primary purposes. First, it provides the Army, EPA, and ADEM with information about community concerns with the IRA and preferences about the Preferred Alternative presented in the PP. Second, it shows how the public's comments were factored into the decision making process for selection of the final remedy. Third, it provides a formal mechanism for the Army to respond to public comments.

This Responsiveness Summary documents the formal public comments received on the PP (Shaw, 2007) and the Army's responses to the comments. However, no public comments were submitted during the 30-day comment period that began on July 22, 2007 and ended on August 20, 2007.

LUCs, which were presented as the Preferred Alternative in the PP (Shaw, 2007), are the selected IRA for the IWGW at Redstone Arsenal. This decision is based on the Administrative Record file as well as on the fact that no public comments were received on the Preferred Alternative during the public comment period. EPA and ADEM have expressed concurrence with the selected interim remedy.

4.0 References

A.T. Kearney, 1989, ***Interim RCRA Facility Assessment of the RSA, Huntsville, Alabama,*** prepared for the U.S. Environmental Protection Agency, September.

Geraghty & Miller, Inc., 1991, ***Final Identification and Evaluation of Potential Solid Waste Management Units and Areas of Concern,*** prepared for the U.S. Army Corps of Engineers, February.

Huntsville Utilities, 2006, ***Water Quality Report by Order of the Environmental Protection Agency and the Alabama Department of Environmental Management*** (www.hsvutil.org/about/WQR2006.pdf)

IT Corporation , 2003, ***Final Sitewide Karst Hydrogeologic Investigation, Phase I Report of Findings, Redstone Arsenal, Madison County, Alabama,*** Volumes 1 and 2, prepared for the U.S. Army Corps of Engineers, Savannah District, May.

Shaw Environmental, Inc. (Shaw), 2007, ***Final Proposed Plan, Interim Remedial Action for Installation-Wide Groundwater, Redstone Arsenal, Madison County, Alabama***, prepared for the U.S. Army Corps of Engineers, July.

Shaw Environmental, Inc. (Shaw), 2006, ***Community Relations Plan, Redstone Arsenal, Madison County, Alabama,*** prepared for the U.S. Army Corps of Engineers, March.

Shaw Environmental, Inc. (Shaw), 2005, ***RSA-146 Phase I Remedial Investigation Report, Redstone Arsenal, Madison County, Alabama,*** prepared for the U.S. Army Corps of Engineers, Volumes 1-3, July.

Shaw Environmental, Inc. (Shaw), 2004, ***Final Record of Decision, RSA-099, Abandoned Plating Shop Tanks and Sump, Building 7614, Operable Unit 10, Redstone Arsenal, Madison County, Alabama***, prepared for the U.S. Army Corps of Engineers, Savannah District, September.

U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (EPA), 2000, ***A Guide to Developing and Documenting Cost Estimates during the Feasibility Study,*** EPA 540-R-00-02, OSWER 9355.0-75, USACE Hazardous, Toxic, and Radioactive Waste Center of Expertise, Omaha, NE and EPA Office of Emergency and Remedial Response, Washington, D.C., July.

U.S. Army Garrison – Redstone (Army), 2006a, ***Redstone Arsenal Environmental Site Access Control Program, Redstone Arsenal Regulation 200-7,*** June.

U.S. Army Garrison – Redstone (Army), 2006b, ***Real Property Master Plan Digest.***

U.S. Army Garrison – Redstone (Army), 2005a, ***Questions and Answers about TCE, Fact Sheet 12,*** Environmental Management Division, October.

U.S. Army Garrison – Redstone (Army), 2005b, ***Questions and Answers about Perchlorate, Fact Sheet 23,*** Environmental Management Division, October.

U.S. Environmental Protection Agency (EPA), 2006, ***2006 Edition of the Drinking Water Standards and Health Advisories***, Office of Water, Washington, District of Columbia, EPA 822-R-06-013, Summer.

U.S. Environmental Protection Agency (EPA), 2004, ***Region 9 Preliminary Remediation Goal Table***, San Francisco, California, October.

U.S. Environmental Protection Agency (EPA), 1999, ***A Guide to Preparing Superfund Proposed Plans, Records of Decision, and other Remedy Selection Decision Documents***, EPA 540-R-98-031, Office of Solid Waste and Emergency Response, July.

U.S. Environmental Protection Agency (EPA), 1991, ***Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions***, Directive 9355.0-30, Office of Solid Waste and Emergency Response, April.

FIGURES

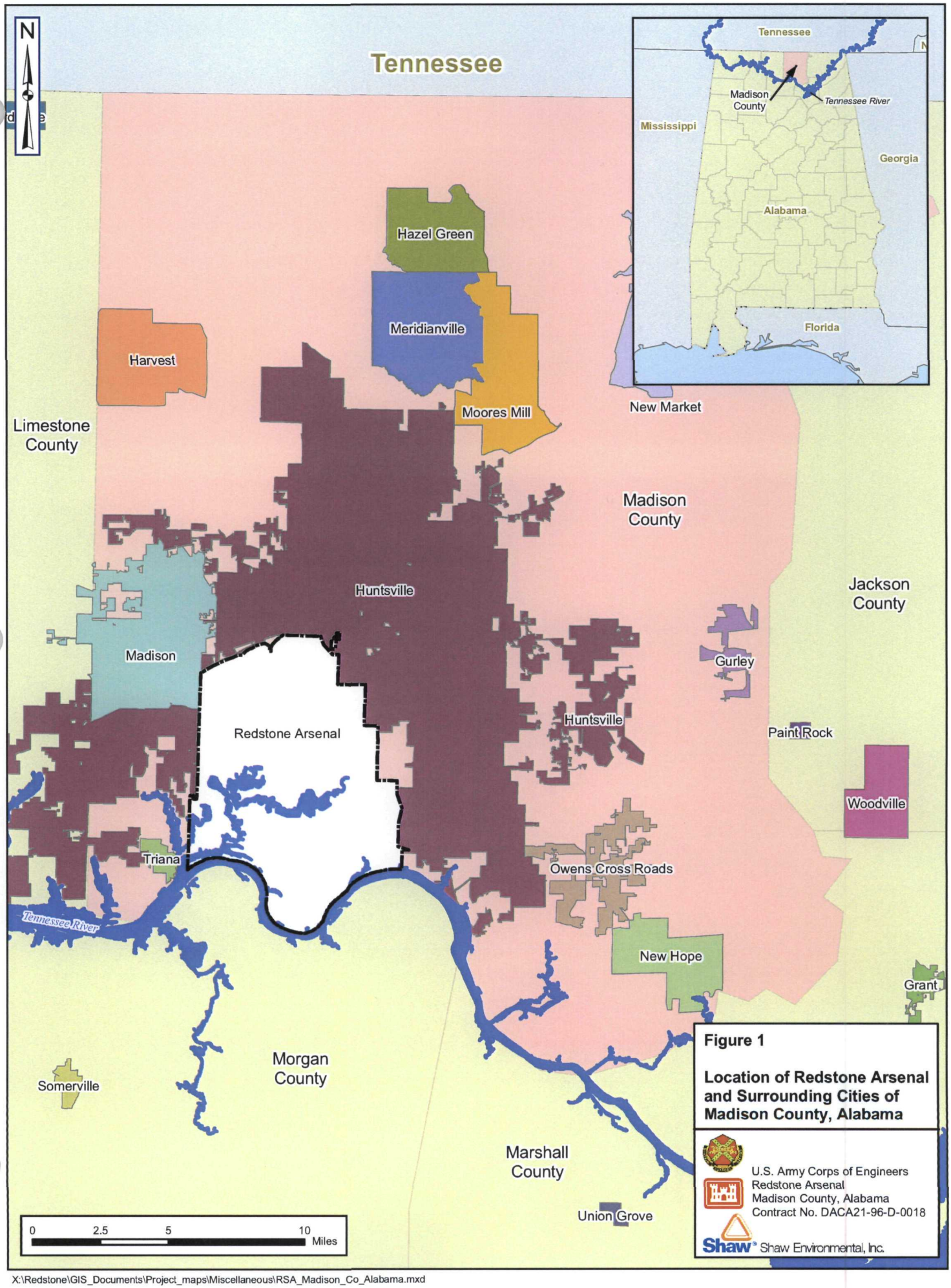

Figure 1

Location of Redstone Arsenal and Surrounding Cities of Madison County, Alabama

U.S. Army Corps of Engineers
Redstone Arsenal
Madison County, Alabama
Contract No. DACA21-96-D-0018

Shaw® Shaw Environmental, Inc.

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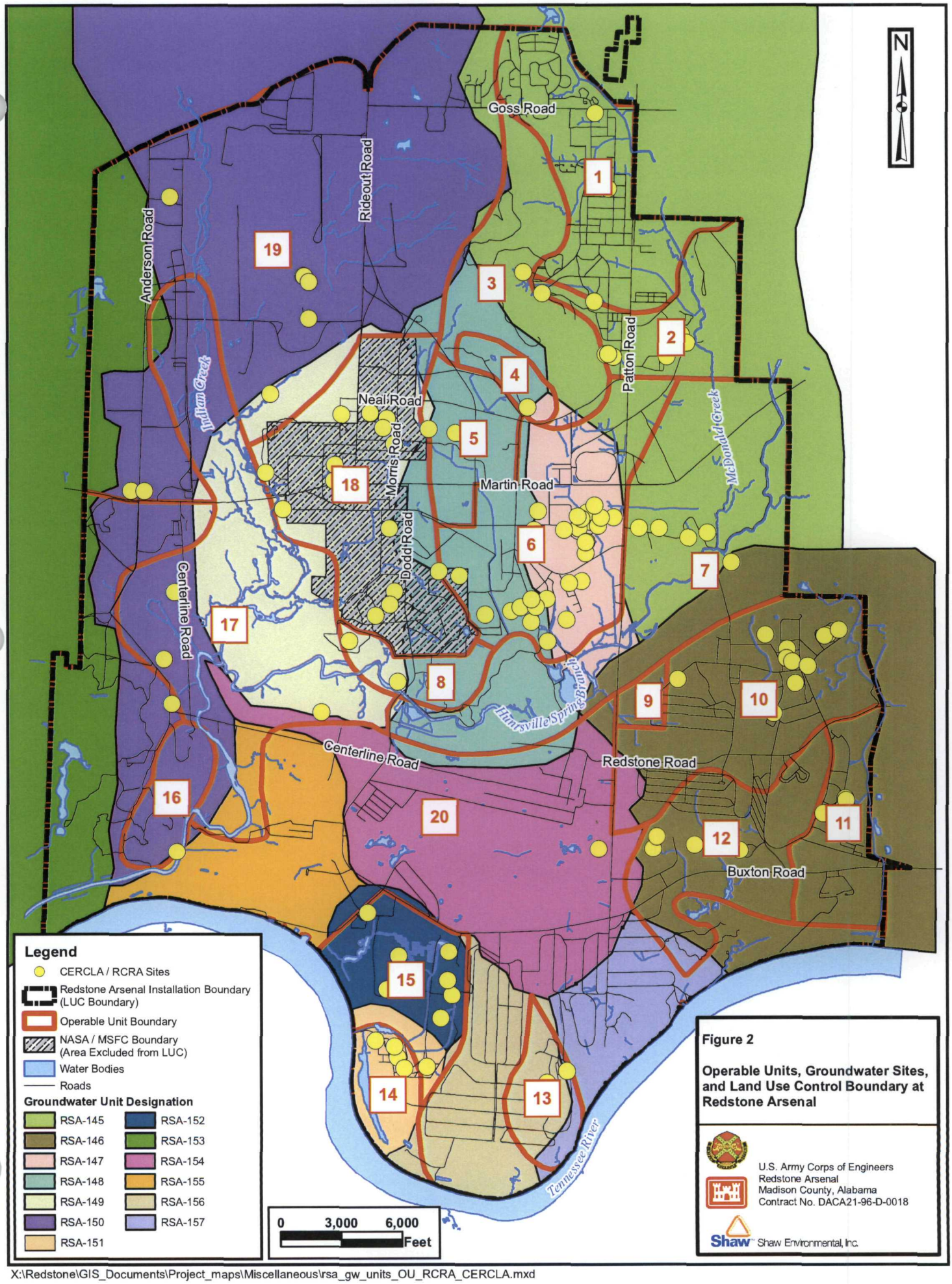

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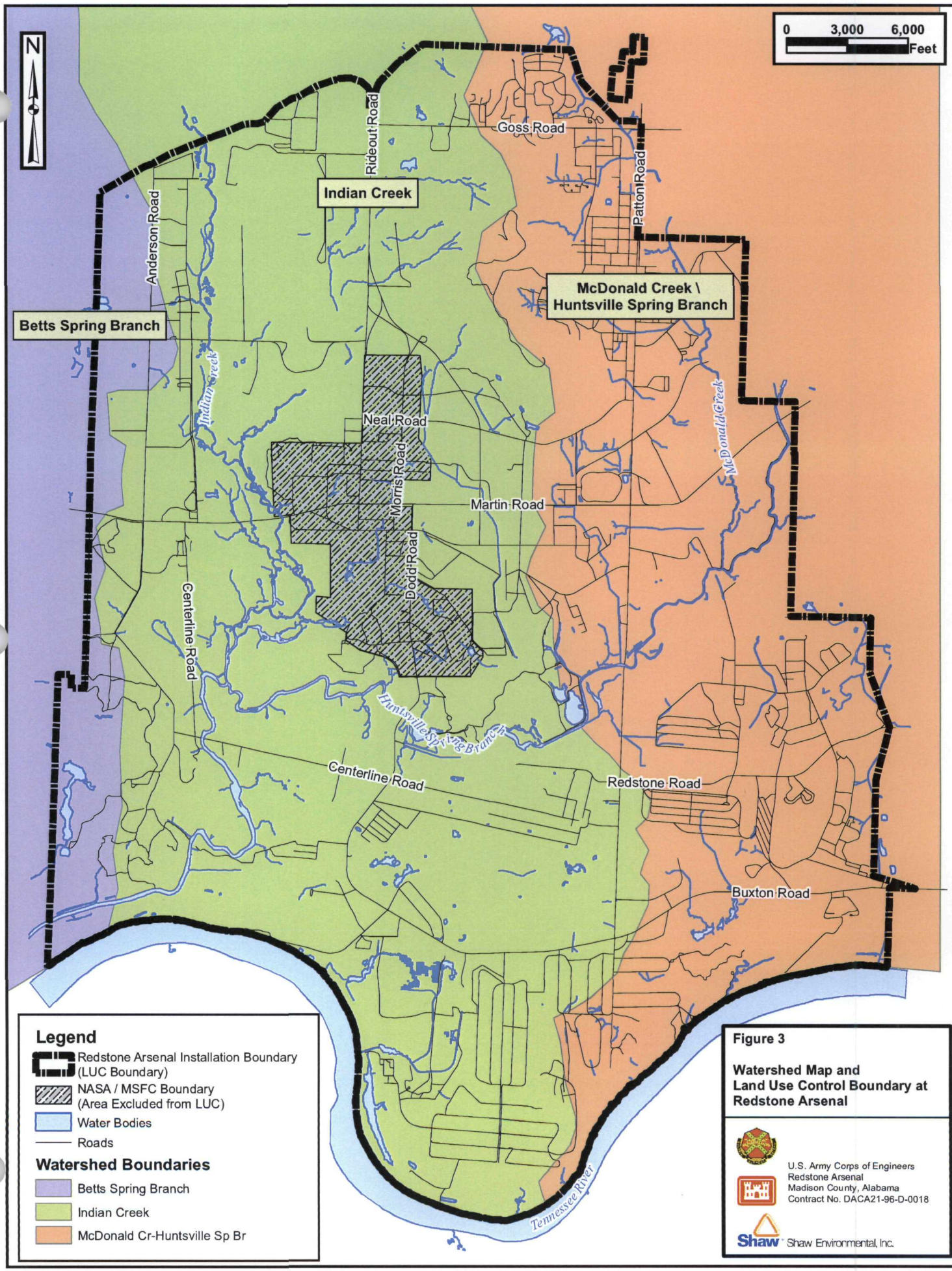

Figure 3

Watershed Map and Land Use Control Boundary at Redstone Arsenal

U.S. Army Corps of Engineers
Redstone Arsenal
Madison County, Alabama
Contract No. DACA21-96-D-0018

Shaw Environmental, Inc.

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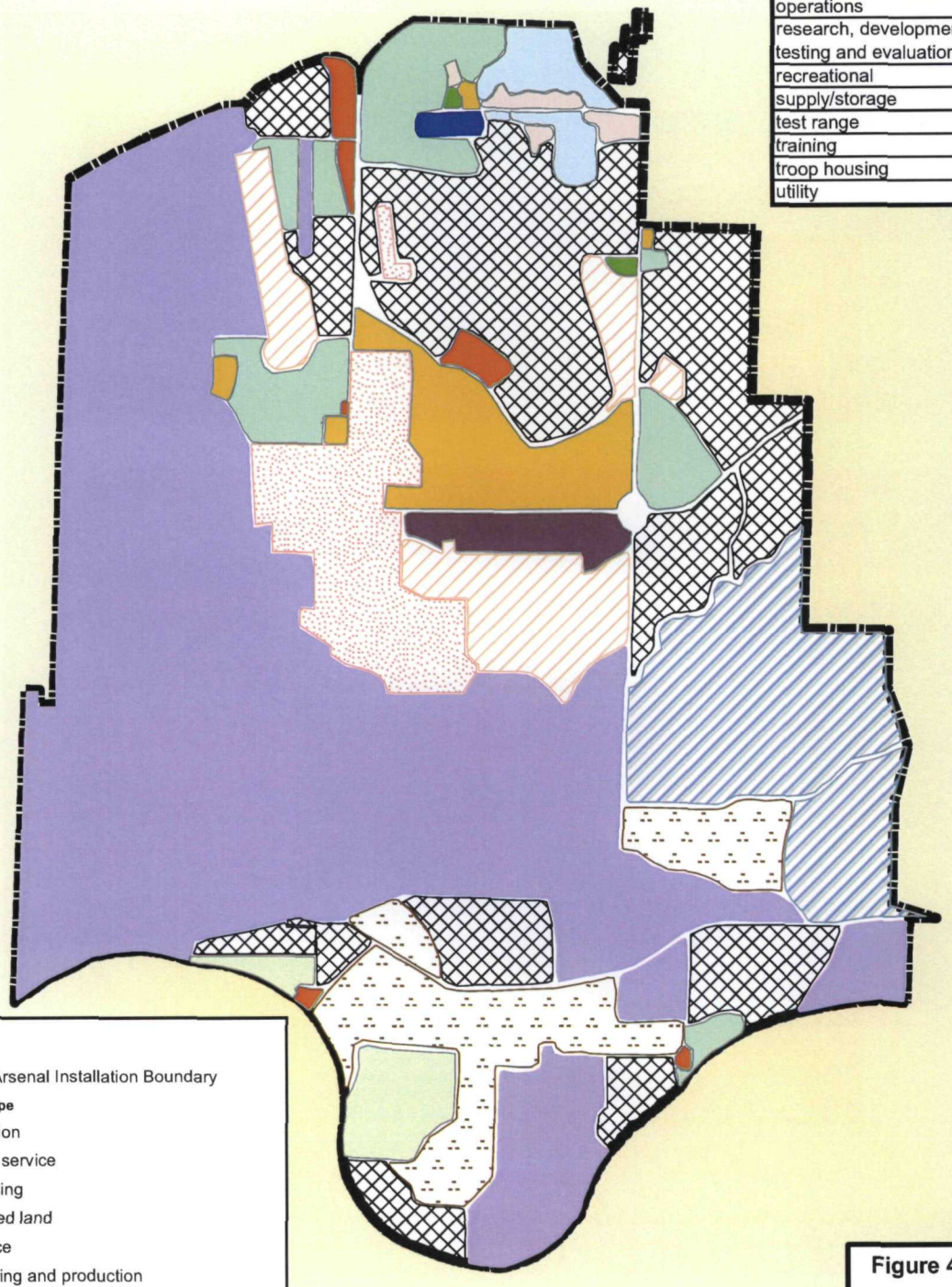
Land Use Type	Acres
administration	1314.71
community service	177.77
family housing	471.52
NASA leased land	1922.43
maintenance	642.56
manufacturing and production	3056.29
medical/dental	78.78
operations	1770.61
research, development, testing and evaluation	421.50
recreational	1816.29
supply/storage	2348.14
test range	14925.50
training	6915.14
troop housing	38.93
utility	290.31



Legend

Redstone Arsenal Installation Boundary

Current Land Use Type

- administration
- community service
- family housing
- NASA leased land
- maintenance
- manufacturing and production
- medical/dental
- operations
- recreational
- research, development, testing, and evaluation
- supply/storage
- test range
- training
- troop housing
- utility

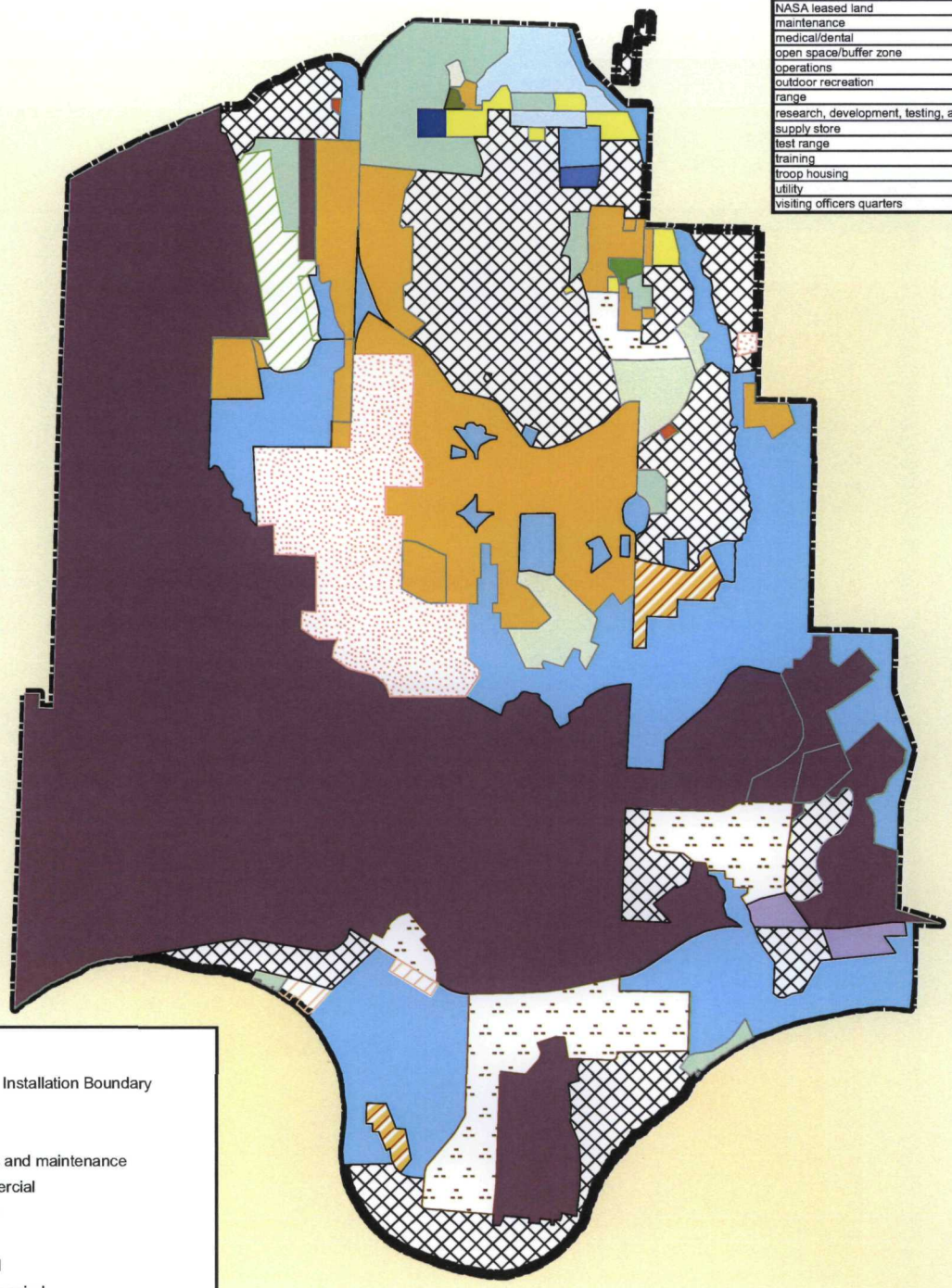
0 3,000 6,000 Feet

Figure 4

Current Land Use at Redstone Arsenal

U.S. Army Corps of Engineers
Redstone Arsenal
Madison County, Alabama
Contract No. DACA21-96-D-0018

Shaw Shaw Environmental, Inc.



Land Use Type	Acres
administration	3261.89
aircraft operations and maintenance	473.20
community commercial	17.06
community facility	234.46
family housing	359.79
house unacompanied	39.53
NASA leased land	1878.18
maintenance	514.58
medical/dental	37.88
open space/buffer zone	5868.08
operations	80.69
outdoor recreation	1080.98
range	285.57
research, development, testing, and evaluation	16078.26
supply store	1832.19
test range	177.91
training	5941.00
troop housing	31.81
utility	15.15
visiting officers quarters	14.78

Legend

Redstone Arsenal Installation Boundary

Future Land Use Type

- administration
- aircraft operations and maintenance
- community commercial
- community facility
- family housing
- NASA leased land
- housing unaccompanied
- maintenance
- medical/dental
- open space/buffer zone
- operations
- outdoor recreation
- range
- research, development, testing, and evaluation
- supply/storage
- test range
- training
- troop housing
- utility
- visiting officers quarters

0 3,000 6,000 Feet

Figure 5

Future Land Use at Redstone Arsenal

U.S. Army Corps of Engineers
Redstone Arsenal
Madison County, Alabama
Contract No. DACA21-96-D-0018

Shaw Environmental, Inc.

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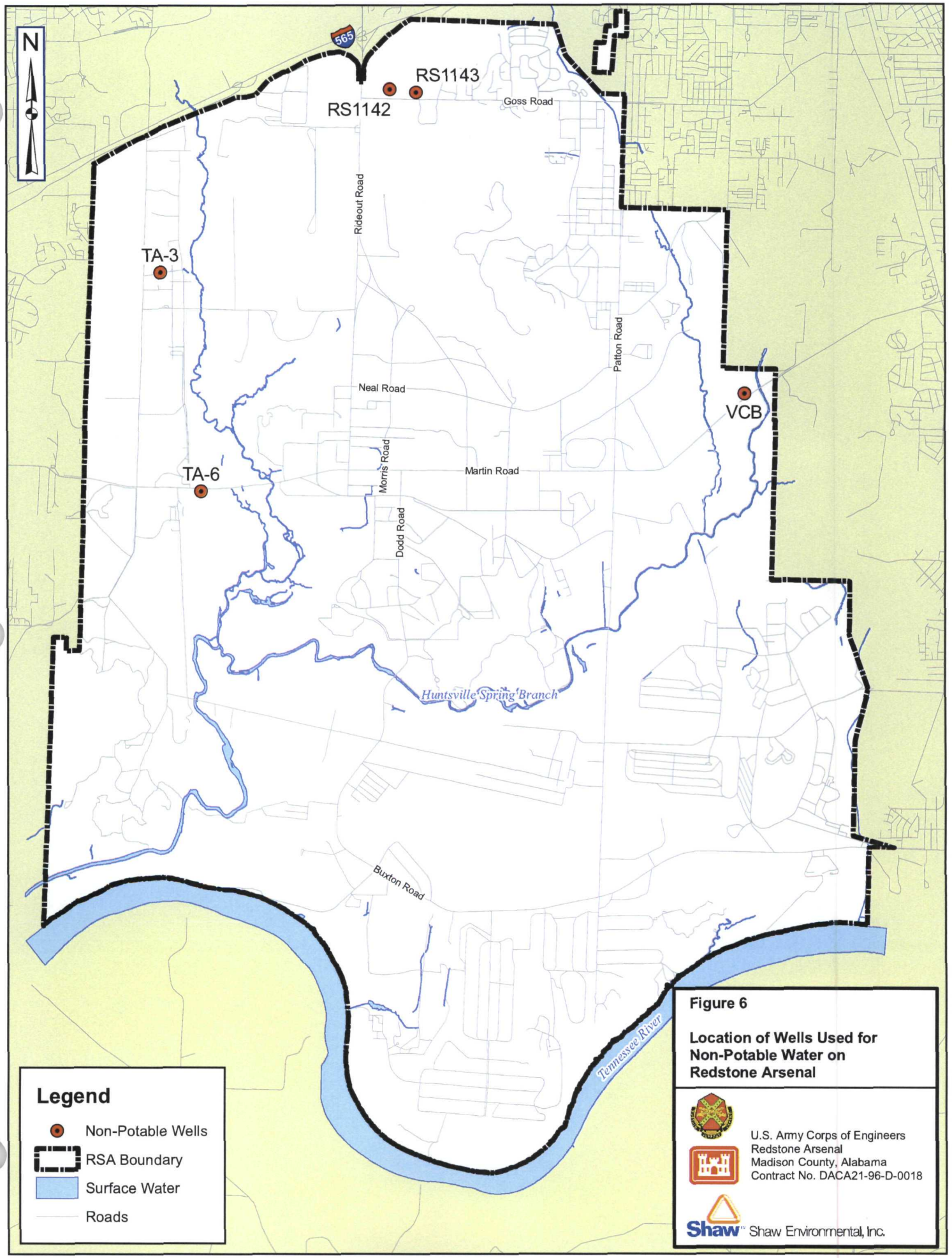

Figure 6

Location of Wells Used for Non-Potable Water on Redstone Arsenal

U.S. Army Corps of Engineers
Redstone Arsenal
Madison County, Alabama
Contract No. DACA21-96-D-0018

Shaw Environmental, Inc.

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APPENDIX A

GLOSSARY OF TERMS

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Glossary of Terms

Administrative Record file – The body of reports, official correspondence, and other documents that establish the official record of analysis, cleanup, and final closure of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) site.

Applicable or Relevant and Appropriate Requirements (ARARs) – Evaluates whether an alternative will satisfy promulgated substantive standards, requirements, criteria, or limitations pertaining to the chemicals of concern (COC) that require response actions as established in Federal environmental laws or regulations and State environmental or facility siting laws or regulations. ARARs may be waived under certain circumstances.

Characterization - The compilation of all available data about the waste unit to determine the rate and extent of contaminant migration resulting from the waste site, and the concentration of any contaminants that may be present.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 1980 - CERCLA was enacted by Congress in 1980 and was amended by the Superfund Amendments and Reauthorization Act in 1986. CERCLA provides federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. CERCLA established prohibitions and requirements concerning closed and abandoned hazardous waste sites and established the Superfund Trust Fund.

Contaminant Plume – A column of contamination with measurable horizontal and vertical dimensions that is suspended and moves with groundwater.

Drinking Water – Water that is intended to be ingested by humans.

Exposure – Contact of an organism with a chemical or physical agent. Exposure is quantified as the amount of agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut) and available for absorption.

Feasibility Study (FS) - Process for evaluating potential remedial options for cleanup at a site.

Groundwater – Underground water that fills pores in soil or openings in rocks to the point of saturation. Groundwater is often used for drinking water via municipal or domestic wells. Groundwater that comes to the earth's surface, such as streams and springs, is considered surface water. At Redstone, the groundwater is not currently a source of drinking water.

Groundwater Sites – Constitute sub-watersheds defined at Redstone Arsenal from a sitewide hydrogeologic investigation. Each groundwater site will proceed through a separate CERCLA investigation to get to closure of the site.

Integrator Operable Unit – Approach to investigating and remediating the releases that occur to groundwater and later up well elsewhere in wetlands and surface water bodies around the Arsenal.

Interim Record of Decision – A legal document that explains to the public which interim clean up alternative will be used at a site until a final record of decision is in place. The document is based on information collected from the site, site risks, remedial alternatives, and consideration of public comments and concerns.

Interim Remedial Action – Action taken to quickly protect human health and the environment from an imminent threat while a final remedial action is being developed, or to institute temporary measures to stabilize a site or prevent further migration of contaminants.

Karst – Consists of water soluble carbonate rock (principally limestone and dolomite) in which chemical dissolution has enlarged joints, bedding planes, and other water-transmitting openings.

Land-Use Controls (LUC) – Any type of physical, legal, or administrative mechanism that restricts use of, or limits access to real property to prevent or reduce risks to human health and the environment. Can include engineering/access controls, institutional controls, and educational/notification programs.

Maximum Contaminant Level (MCL) – The highest level of a contaminant that is allowed in drinking water for water treatment plants as established by EPA under the Safe Drinking Water Act.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP) – Provides the Federal government's blueprint for responding to oil spills and hazardous substance releases.

National Priorities List (NPL) – The EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. EPA is required to update the NPL at least once a year.

Nonpotable Water – Water deemed unsafe for human consumption or is of questionable potability. Nonpotable water has other uses such as irrigation, firefighting, controlling construction dust, filling for fountains and ponds, making concrete, drilling fluids, etc.

Operable Unit – A discrete portion of a remedial response that comprises an incremental step toward addressing site problems. It can be a geographic area and can address an environmental medium at the site (e.g., groundwater). At Redstone Arsenal, OUs are distinguished primarily by their topographic/watershed and ecological habitat/range standpoints.

Operation and Maintenance (O&M) – Activities conducted at a site after a response action occurs to ensure that the cleanup and/or systems are functioning properly.

Overall Protection of Human Health and the Environment – The assessment against this criterion describes how the alternative, as a whole, achieves and maintains protection of human health and the environment.

Perchlorate – Salts that are used in the manufacture of matches, automobile airbag inflators, and solid fuel for rockets and missiles. Perchlorate salts dissolve easily in water. Perchlorate is of concern at Redstone because of the Army's historical use in solid fuel for rockets and missiles.

Potable Water – Water of sufficient quality to serve as drinking water even though it may not be used for such purposes. Meets stringent requirements for sanitation and chlorination.

Principal Threat Waste - Source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

Proposed Plan (PP) – Document that presents the Preferred Alternative to the public. Plan briefly summarizes the alternatives evaluated, highlighting the key factors that led to identifying the Preferred Alternative.

Record of Decision (ROD) – A legal document that explains to the public which remedial clean up alternative will be used at a site. The ROD is based on information and technical analysis generated during the remedial investigation, risk assessments, feasibility study, and consideration of public comments and concerns.

Remedial Investigation (RI) – A study designed to gather data needed to determine the nature and extent of contamination at a Superfund site. The RI at Redstone includes a baseline human health risk assessment and a screening-level ecological risk assessment.

Resource Conservation and Recovery Act (RCRA), 1976 – A Federal law that established a regulatory system to track hazardous substances from their generation to disposal. The law requires safe and secure procedures to be used in treating, transporting, storing, and disposing of hazardous substances. RCRA is designated to prevent the creation of new, uncontrolled hazardous waste sites.

Responsiveness Summary – A summary of oral and/or written comments received during the proposed plan comment period and includes responses to those comments. The Responsiveness Summary is a key part of the ROD, highlighting community concerns.

Soil vapor (soil gas) – Air and vapor that resides in the interstitial pores between soil particles.

Surface Media – The soil (surface and subsurface) present at a site. May also include surface water, sediment, and soil vapor. The source material in the surface media may be contributing to groundwater contamination.

Trichloroethene (TCE) – TCE is a colorless or blue liquid with an odor similar to ether. It is man-made and does not occur naturally in the environment. TCE was once commonly used to remove oils and grease from metal parts.

Volatile Organic Compounds (VOC) – Chemical compounds that have high vapor pressures under normal conditions to significantly vaporize and enter the atmosphere. VOCs are present in the groundwater at Redstone.

APPENDIX B

FEDERAL FACILITY LAND-USE CONTROL RECORD OF DECISION CHECKLIST

Appendix B

Federal Facility Land Use Control Record of Decision Checklist

This checklist has been applied to the Installation-Wide Groundwater (IWGW) interim record of decision (IROD) at Redstone Arsenal. The Army will prepare and submit a land-use control (LUC) remedial design (RD) document within 90 days of ROD signature. This LUC RD document will provide the implementation actions for the LUC objectives presented in the ROD.

1. **Map/figure showing boundaries of the land use controls.**

   Figures 2 and 3 present the boundary of the LUC. This boundary is the Redstone Arsenal boundary and excludes the George C. Marshall Space Flight Center. The LUC RD document will contain additional maps and figures as required.

2. **Document risk exposure assumptions and reasonably anticipated land uses, as well as any known prohibited uses which might not be obvious based on the reasonably anticipated land uses. (For example, where "unrestricted industrial" use is anticipated, list prohibited uses such as on-site company day-care centers, recreation areas, etc.).**

   The information on the risk exposure assumptions is presented in Section 2.7. Anticipated land use is presented in Sections 2.6.1 and 2.6.2. Prohibited land uses are discussed in Sections 2.6.2, 2.9.2, and 2.12.1.

3. **Describe the risks necessitating the LUCs.**

   Section 2.7 describes the potential risks to human health which necessitates the LUCs.

4. **State the LUC performance objectives.**

   Sections 1.4, 2.8, and 2.9.2 describe the performance objectives to be attained by the LUCs.

5. **Generally describe the LUC, the logic for its selection and any related deed restrictions/notifications.**

   Sections 2.9.2 and 2.11.1 describe the LUCs and the rationale for their incorporation as a component in the remedy.

6. **Duration language: "Land Use Controls will be maintained until the concentration of hazardous substances in soil and groundwater are at such levels to allow for unrestricted use and exposure."**

   Section 2.9.2.1 presents the LUC duration language.

7. **Include language that the [federal agency] is responsible for implementing, maintaining, reporting on, and enforcing the land use controls. This may be modified to include another party should the site-specific circumstances warrant it.**

See Section 2.9.2.1 for LUC maintenance and reporting language.

8. **Where someone else will or the federal agency plans that someone else will ultimately be implementing, maintaining, reporting on, and enforcing land use controls, the following language should be included:**

"Although the [federal agency] may later transfer [has transferred] these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the [federal agency] shall retain ultimate responsibility for remedy integrity."

This item is not applicable.

9. **[ONLY INCLUDE IN NON-AF RODS] Refer to the remedial design (RD) or remedial action work plan (RAWP) for the implementation actions. Because this is a new idea (i.e., including the LUC implementation actions in either or both of these two primary documents) to ensure that the requirement is clear and enforceable, we developed the following language where it makes sense:**

"A LUC Remedial Design will be prepared as the land use component of the Remedial Design. Within 90 days of ROD signature, the [federal agency] shall prepare and submit to EPA for review and approval a LUC remedial design that shall contain implementation and maintenance actions, including periodic inspections." Another option is to refer to the enforceable schedule in the IAG for the RD or RAWP.

Sections 1.4 and 2.9.2 presents the LUC RD language for the implementation actions.